PEARL

The Journal of HEREDITY

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Dual Purpose Sheep Breeds of Germany

Genetics of Face Patterns in Arab Horses

Genes for Piebald Pattern in the Deer Mouse

The Place of Environment in a Eugenics Program

Heroes and Villains in the Newer Biochemical Drama

Salivary Gland Chromosome Map of Drosophila Virilis

VOLUME 27 AUGUST, 1936 NUMBER 8

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 32nd Street and Elm Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 308, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 32nd Street and Elm Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918.

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The

Journal of Heredity

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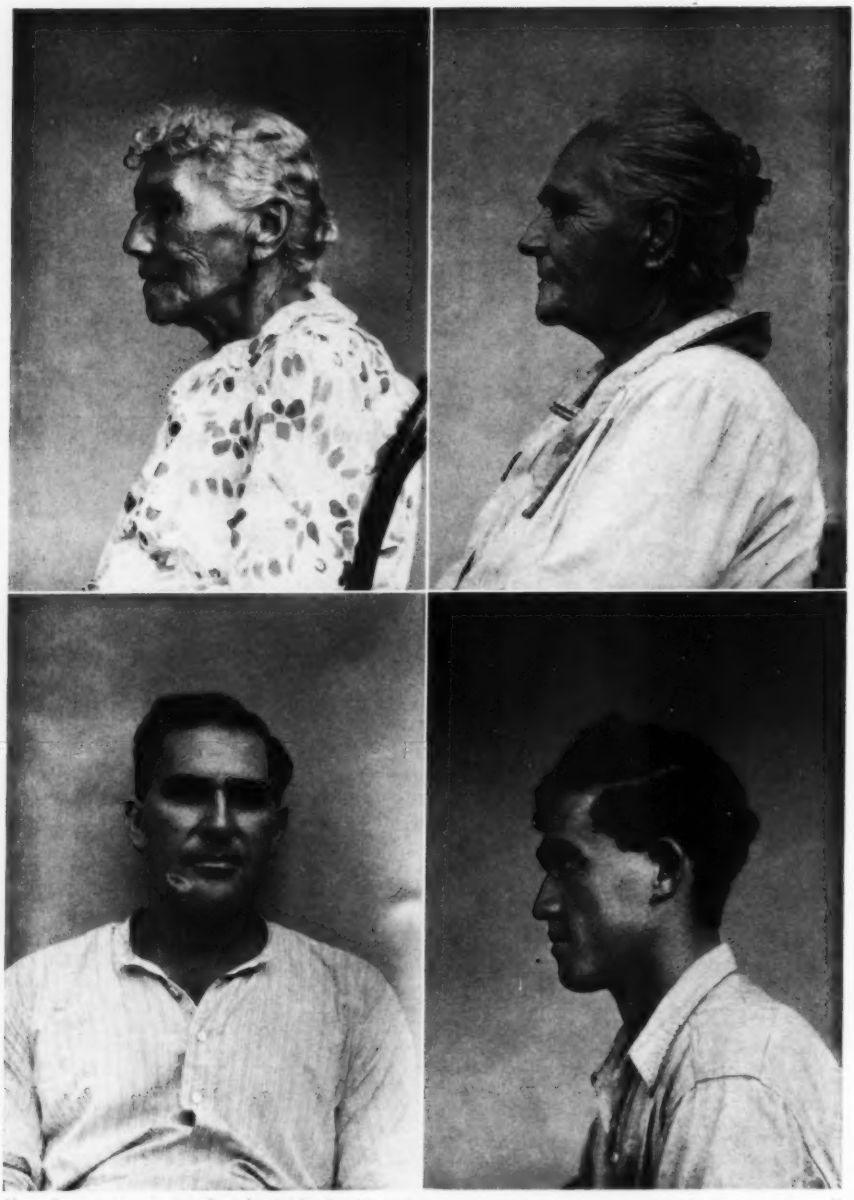


DESCENDANTS OF THE BOUNTY MUTINEERS

Frontispiece

The men and women now living on Pitcairn Island are the fifth and sixth generations from the original settlers,—six mutineers from the *Bounty* expedition and nine Polynesian women. Mary Ann McCoy (upper left) was the oldest inhabitant of Pitcairn at the time of Dr. Shapiro's visit. She went as a child to Norfolk Island in 1856 and returned to Pitcairn in 1859. Dr. Shapiro obtained much valuable genealogical information from her. Below her is Burley Warren, Dr. Shapiro's host on Pitcairn Island. He is descended from Samuel Warren, a sailor from Providence, Rhode Island, who joined the colony on Norfolk Island and came to Pitcairn with the second group of "remigrants" in 1864. The other two are types of Pitcairners of the older and younger generations. Impressed by the large number of fine people he met among the 200 inhabitants, Dr. Shapiro can only conclude that "as far as our evidence goes [inbreeding] has not caused degeneration among the Pitcairn Islanders." Photographs courtesy of Dr. Harry L. Shapiro.

NEWS FROM THE *BOUNTY*

A Review

PLANT introduction has produced profound and dramatically unexpected changes in human history. It has been a basic factor in the development of industries, of great regions, and even of nations. If Ridley had not persevered in learning how to grow the Para Rubber Tree in the East Indies, the automobile industry would very likely have had quite a different history. When an unprecedented demand for the juice of *Hevea braziliensis* arose, by a miracle of coincidence it had migrated from the jungles of Brazil, and was by way of settling down to a quiet plantation existence on the other side of the globe, where it grew in such abundance that its "milk" could be collected by the shipload. Of even more portentious significance is the claim that the 1914 bumper crop of the so-called "Irish potato" was an important factor in setting the stage for the tragedy of the World War. Thus did the Incas of Peru in their gift of *Solanum tuberosum,* "More valuable than all the gold of the Indies," play an involuntary part in initiating what some see as the first act of the "mechanized hari-kari" of the Western world.

The altogether unpredictable results of plant introduction represent one of its most fascinating features. Man does not like to consider himself a laboratory mammal, and will play that useful role only involuntarily and in blissful unconsciousness. The most extensive "laboratory experiment" in human inbreeding on record is to be credited as a by-product of plant introduction, by a remarkable set of curious occurrences. In order to make a test of what kind of people the sixth inbred generation of an English × Polynesian cross would be, the following far flung series of events made essential contributions to setting the stage for the experiment:

1. 1492, Columbus reaches America.
2. About 1550, African slaves reach the Western Hemisphere.
3. 1775, Captain Cook brings back from the Pacific Islands Omai, a native Tahitian, and enthusiastic accounts of the breadfruit.
4. 1780-85, English planters in the West Indies see in this crop possibilities of a ration for slaves on their plantations.
5. 1787, Lieutenant William Bligh of His Majesty's Navy, ordered to fit out the *Bounty* expedition to bring the breadfruit to the West Indies, so that the planters may have the slave food-problem permanently solved.

Recently in books, magazines, moving pictures, and radio the story of the immediate happenings leading to the peopling of Pitcairn Island has been told and retold several times so that many of us know more about the state of the British navy in the 1780's than we know about our own navy today. "The Mutiny on the Bounty" is now reaching the re-run movie houses, and for 25c anyone who has not already done so can get a deal of local color, apparently quite accurately laid on, through the medium of two hours of harrowing entertainment. Captain Bligh did not succeed as a plant introducer. When we consider that out of his ill-starred expedition came such diverse by-products as our most nearly perfect human genetic experiment, the first adoption of a votes for women law, and considerable reorganization of the disciplinary customs of the navies of the world, we must credit him with perhaps the palm in unintentional explorational bulls' eyes!

The upshot of all the altruism, brutality, generosity, greed, privation, and other emotions and reactions included in this centuries-long list of apparently unrelated circumstances was that on September 2, 1789, nine of the *Bounty* mutineers and nine Tahitian women, twelve Tahitian men, and eight boys, sailed out of the world and disappeared for nearly a generation as completely as though the Pacific had opened and swallowed them. At about this point most of the accounts of the *Bounty* inci-

dent end in a "fadeout." We have fleeting glimpses of island paradises or man-made Hells, as the imagination of the writer, inspired by fragmentary records, dictates. We have few consistent accounts of what transpired between 1790 and 1935. There is excellent reason for this. Pitcairn Island, about four thousand miles from anywhere else on earth, is not easily reached. Only an inspired scholar of considerable determination could bring the story accurately up to date.

Students of human biology and many others of less specialized interests are fortunate that at last "the essential man" has appeared on the scene,—one who combined the rare qualities of the necessary biological and anthropological background, an able pen, and that essential—so essential—quality of persistence. When the author of this book* was a student at Harvard in 1922 he was fired with an ambition to see the unique Pitcairn experiment in human hybridization at first hand. He began his "trip to Pitcairn" at once, by exhausting every reference he could find regarding the islanders and their history. This "voyage of the spirit" lasted for eleven years, and then the first attempt to translate it to a visit in the flesh ended in failure. The boat on which Dr. Shapiro embarked at Panama, hoping to stop at Pitcairn en route to New Zealand missed the island. Lack of time and money made it impossible for Dr. Shapiro to retrace his steps to Panama and try again (for only outbound boats ever stop at Pitcairn). He therefore did the next best thing, since he was on the ground, and visited Norfolk Island, where is located a colony of the descendants of the *Bounty* mutineers. Disappointed but not discouraged by the failure of his first attempt, Dr. Shapiro bided his time, and ten years later, on Christmas Eve, 1934, finally landed on Pitcairn Island, 147 years to the day after the *Bounty* sailed from Spithead, England.

The book which has resulted from this trip is woven so closely around the ten days spent there that a review of any reasonable length cannot possibly do justice to all of it. It would be unfair even to make the attempt, for the book should be required reading for every person intelligently interested in his very closest relative, *Homo sapiens* (and what *intelligent* person is not?). It combines many facts about a fascinating human experiment with much of the excitement of the best historical fiction. With the adjuration "buy, borrow or steal the book, or somehow read it," we turn to the final section, which deals with the "biological experiment which blind circumstances created on Pitcairn," where for six generations the external factors have been reduced to a minimum while the descendants of six Englishmen and nine Tahitian women have worked out their destiny.

Two chapters are devoted to the cultural aspects of the experiment, and two to the biological aspects. Dr. Shapiro has in preparation a monograph presenting in detail the data which he collected during his ten-day visit to the island. Final conclusions from the genetic data obtained by him will have to await the publication of this work. In this popular treatise he has only attempted to show by general summaries some of the more important sociological and genetic conclusions to be obtained from these interesting data. Thus Chapter XI (Breeding and Inbreeding) is in some respects a promise rather than a fulfillment. Nevertheless there is enough meat on this outline-skeleton, so that we cannot complain too loudly. When the detailed pedigrees are published it will be possible to make exact comparisons between human genetics on Pitcairn and laboratory genetics in other organisms.

A Complete Record

Some of the vital statistics are given in enough detail to be of great interest. Before they can be considered, a word

*THE HERITAGE OF THE BOUNTY, The Story of Pitcairn through Six Generations, *by* HARRY L. SHAPIRO. Pp. 330. Price, $3.00. New York: Simon and Schuster. 1936.

THE YOUNGER GENERATION ON PITCAIRN

Figure 1

Group of children of the *Bounty* mutineers' descendants in the sixth and seventh generation. In spite of having fewer ancestors than most people not the product of a race cross, the Pitcairn Islanders appear to be at least averagely well equipped physically and mentally. Photograph courtesy of Dr. Harry L. Shapiro.

is necessary regarding the islanders. Since the early days of the colony a careful record has been kept of all births, deaths, marriages, and other vital information. The illigetimacy rate has been astonishingly low, so that the data have considerable genetic validity. The original settlers were augmented before the middle 1800's by four Englishmen and one American, so that there have been some back-crosses to the Anglo-Saxon. These influences are all in the record, however, and no other as extensive a record of an inbred race cross exists in the knowledge of the reviewer.

Twice the descendants of the *Bounty* have left their island home, and each time some of them have returned to their tiny fatherland (a mile long by three-quarters of a mile wide, in millions of square miles of ocean), so that the experiment has not been affected by these journeyings. In 1831 the entire Pitcairn colony was removed by the British Government because of a severe drought and crop failure on the island. All of the islanders were taken back to Tahiti, but they were not happy there. The levity of Tahitian existence was looked at askance, and sickness made serious inroads. The Pitcairners were so disgusted that the 71 survivors (17 died during the unfortunate expedition) returned to the island the same year.

In 1856 the population had reached the alarming total of 192. Danger of over-population had become so great that the colony was again removed by the British Government, this time to Norfolk Island, 4,000 miles west of Pitcairn, where formerly had been located a British penal colony. All of the people living on Norfolk Island in connection with this colony were removed and the buildings were turned over to

the Mutineers' descendants. Norfolk Island is a considerably larger island than Pitcairn—fertile and well watered. In spite of this the Pitcairners were not happy, and two years later 16 of them went back to their lone rock in the Pacific. By 1864, 26 more had joined them. The 1858 "re-migrants" had wasted no time in indulging their fertility, so that by the end of 1864 about 45 descendants of the *Bounty* mutineers were again living on Pitcairn. The population growth curve since then is given in Figure 2. Thus by 1934, 145 years after "the six mutineers who lived long enough to produce offspring have a living progeny well exceeding 800 on Norfolk and Pitcairn and which might easily number 1,000 if all the wanderers were included. A prodigious spectacle of human breeding."

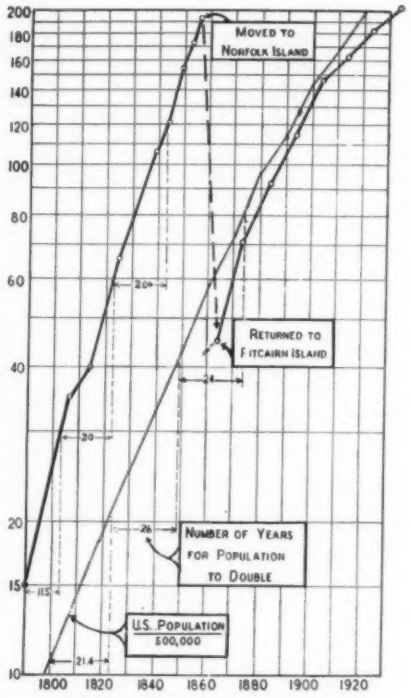
The present population living on the island is as follows:

	Males	Females
Under 18	36	27
18-44	44	38
45-64	18	24
65-86	3	9
Total	101	98

Since 1865 there have been 165 male births to 139 female births on the island, a rather high sex ratio of 118.7 (1929 U. S. ratio = 105.5). The mortality rate has varied in the last 50 years from 7 per cent per year in 1874 to as high as 18 per cent in 1894, and 10 per cent in 1934. The birth rate presents an interesting situation in the light of reproductive trends in all Western countries. The statistics for all women regardless of their sex history, living on the island for whom data are available are as follows:

Birth Year of Mother	Number of Women	Average Number of Children per Female
1790-1814	2	5.5
1815-1839	5	11.4
1840-1864	12	6.8
1865-1889	31	4.2
1890-1914	33	2.4

For the women married and living to 45 or over, the statistics for this period are as follows:



POPULATION GROWTH ON PITCAIRN ISLAND

Figure 2

Growth curves of the population of Pitcairn Island compiled from the careful vital statistics kept by the islanders. The average time required for the population to double during the first four generations was considerably less than twenty years. For comparison the growth curve of the population of the United States (corrected for immigration, but including the children of immigrants) from 1800 to 1920 is given (divided by 500,000). Since the immigrants represent a relatively prolific fraction of the American population, a comparison which took into account only the descendants of those arriving before 1790 would show more striking differences.

Birth Year of Mother	Number of Matings	Average Number of Children per Female
1790-1814	1	6.0
1815-1839	5	11.4
1840-1864	8	8.0
1865-1889	20	5.0
1890-1914	2	2.5

By generations the birth rates have been as follows:

	Number of Women	Number of Children Per Mating
Original Cross	6	4.17
First generation	9	7.44
Second generaiton	38	9.10
Third generation	77	5.39
Fourth generation	26	2.96

It is evident that the first generation of the cross had a remarkably high fertility, but the second generation did even better. The phenomenon of hybrid vigor (heterosis) is limited exclusively to the first generation of a cross, so that this remarkable fertility can hardly be considered to be a demonstration of hybrid vigor in man. It is more a demonstration that a favorable age-distribution and an adequate food supply are the basis of the perfect human multiplication table.

There has been a steady decline in the birth rate with the passing generations until at present it approaches very closely to that of European and American populations. Dr. Shapiro discusses this question of declining fertility at considerable length and is not sure what is the cause. Disease is a possible factor, but he was not able to obtain much data on this point since he was only there a short time, and since he found it hardly feasible to discuss intimate health problems with a group of Seventh-day Adventists. (The arrival of a box of Adventist tracts in 1876 followed by a missionary of the sect ten years later served to divorce the Pitcainers permanently from the Church of England.) Thus the possibility that venereal infection may have reduced the birth-rate could be disposed of by Dr. Shapiro only by inference.

If disease is not the main factor in the falling Pitcairn birthrate, two other possibilities next suggest themselves: deliberate birth limitation and the appearance of genetic recessive sterility factors brought to light by inbreeding. Dr. Shapiro was able to get no information regarding birth-control on Pitcairn during his brief stay, for the same reasons that he did not learn anything regarding diseases. The existence of genetic sterility factors has been demonstrated in more than one genetic experiment in mammals. These factors are necessarily recessive in inheritance, and more than one gene seems usually involved. Their expression would, therefore, be facilitated by inbreeding. This possibility seems to fit into the picture fairly well, but in the light of existing information must remain purely speculation. There is also the question of just how much inbreeding has actually occurred, which will be discussed below. The complete data might throw some light on such a possibility by showing that certain lines are decreasing in fertility more than others. If such a mechanism is operative it is most interesting from a biological standpoint, because it means that the future generations of Pitcairners, if the island is left to its own devices, may come from a relatively small proportion of the present population, and will probably be more highly inbred than the present population. For a population living on a very limited terrain there is even the paradoxical possibility that such sterility factors might have definite survival value.

The growth curve of the Pitcairn Islanders is an astonishing exhibit of human fertility. Starting with 15 reproducing individuals in 1790 the population had grown by 1808 to 35—more than doubling in something less than 18 years! By 1825 it had grown to 66, just short of doubling again in 17 years. By 1846 it had grown to 134, doubling in 21 years. In the next 20 years intervening before the move to Norfolk Island the population had reached 193, not quite doubling this time. After this excursion, reproduction did not really get under way again until about 1864, with "about 45 souls on Pitcairn." In 20 years the population was 92, a little more than double. In the next 20 years things did not go so well, for the total rose only to 147, about a 50 per cent increase. We have in the

BOUNTY BAY AND A CORNER OF ADAMSTOWN

Figure 3

Above is the boat landing at Bounty Bay, and below a "street scene" in Pitcairn Island's sole community. Bounty Bay is the only place where a boat can land on the rocky shores of Pitcairn and here no little nautical skill is needed to bring a boat in safely. The houses of the Pitcairners are constructed along original lines combining Tahitian and British ship architecture, with some original technique. The flora of Pitcairn Island is tropical. Note in this picture coconut palms, orange, and a frangipani tree, and in the middle distance a papaya. An abundant food supply has no doubt contributed to the tremendously rapid growth of the population. Photographs courtesy of Dr. Harry L. Shapiro.

two periods shortly after 1790 and after 1854 an age distribution calculated to produce the highest fertility. The nine hundred per cent increase in the descendants of the *Bounty* mutineers in the 56 years between 1790 and 1846 represents perhaps an all time "high" in human reproductive facility.

Inbreeding

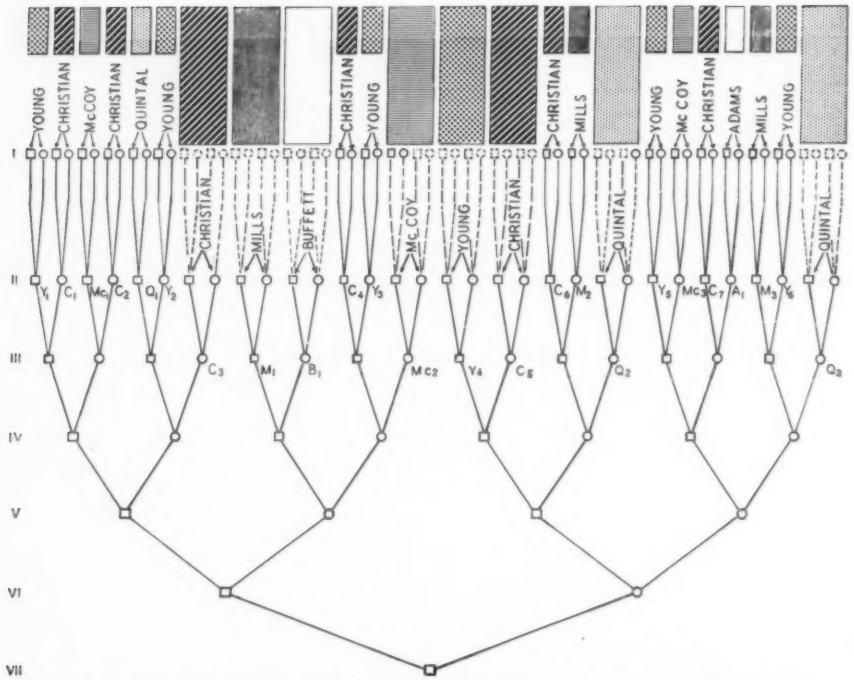
The Pitcairn Islanders have kept accurate records that "make it possible to draw up a family-tree for each individual, and from a study of these genealogical tables we can derive an exact idea of the amount of inbreeding that has occurred in the ancestry of every islander." Dr. Shapiro has compiled indices in this manner for the various generations. Unfortunately he has used for this purpose Pearl's index of inbreeding rather than Wright's index. In the Journal some years ago* the merits of these indices for such a purpose as is now contemplated was discussed. It would seem that for this material Wright's index would have been superior since it measures directly the degree to which inbreeding has reduced the heterozygosity of an individual or a group. Dr. Shapiro feels that for a popular summary the index used by him is easier for the layman to understand and therefore the index of choice. We will await with interest the publication of the full data from which conclusions regarding the degree of homozygosis brought about by six generations of inbreeding can be drawn. The index which Dr. Shapiro used shows the ratio between the actual number of ancestors and the maximum possible number as a percentage. Thus the greater the inbreeding the smaller the index. The offspring of a brother-sister mating has an index of 50 per cent; and of a cousin mating an index of 75 per cent. The location of the repeated ancestors on the family tree is not taken account of. This is crucially important in determining the genetic results of inbreeding. Wright's index expresses the inbreeding directly as a percentage. The inbreeding indices given by Dr. Shipiro are as follows:

	Number	Average Index of Inbreeding
1850-1859	4	84.38 per cent
1860-1869	7	91.07 per cent
1870-1879	15	86.67 per cent
1880-1889	22	70.87 per cent
1890-1899	26	71.36 per cent
1900-1909	26	61.96 per cent
1910-1916	23	51.53 per cent

In a later paragraph the following statement is made: "Nevertheless it is clear that inbreeding among the Pitcairn Islanders is extremely close. One subject had an index of 25.56. In his family tree Fletcher Christian appeared seven times, Edward Young six times, John Mills three times, William McCoy three times, Matthew Quintal three times, John Adams once, and John Buffet once. This young man is a healthy islander and shows no obvious stigmata of his restricted ancestry." This statement gives an opportunity to compare with a fair degree of accuracy the Wright and the Pearl indices.

If we make the assumption that the female ancestry traces back an equal number of times to the wives of Christian, Young, Mills, McCoy, Quintal, Adams, and Buffet, we have a total of 48 "Foundation ancestors" in the fifth and sixth generations. This must represent a complete tale of the original ancestry for there were no more mutineers to trace to, since it is stated elsewhere "only six lived long enough to leave issue" (John Buffet being one of the later immigrants). If we make the assumption that the female ancestry leads only to the seven wives of these individuals our inbreeding coefficient will be higher than if some of the other Tahitan women are also represented in the ancestry. The total of 48 "foundation

* WRIGHT, S. Mendelian Analysis of the Pure Breeds of Livestock. *Jour. Hered.* 14:339-348. 1923.



A "SYNTHETIC" PEDIGREE OF A SIXTH GENERATION PITCAIRNER

Figure 4

For explanation of the reasoning used in the construction of this pedigree see text below. The stipplings and cross-hatchings show the relative contributions of the six mutineers and their Tahitian wives to the ancestry of the individual in question. Adams and Buffet (a later arrival) only appear once, so that there is no inbreeding to them. Such a pedigree may be expected to give a fairly accurate measure of the inbreeding because shifting an ancestor about (in a given generation) on either side of the midline of the pedigree has no effect on the inbreeding coefficient of the propositus. Shifting a given ancestor exclusively to one side of the pedigree or the other reduces his contribution to the inbreeding to zero. According to Wright's index of inbreeding, an individual having the ancestry diagrammed above has an inbreeding coefficient, with respect to the 48 foundation ancestors, of 4.2 per cent. This is less than that of the child of first cousins (6.25%). There may be additional inbreeding to the children and grandchildren of the mutineers. This may greatly exceed the inbreeding to the mutineers themselves, because intensity of inbreeding increases geometrically with the nearness of a common ancestor on the two "branches" of the family tree. No information regarding this point is at present available.

ancestors" means that there is some overlapping of generations, because there are 32 ancestors in the fifth parental generation, and 64 in the sixth. A little computation reveals that the only way in which 48 ancestors can close all lines of descent in the fifth and sixth generations is for 16 of them to be in the fifth generation and 32 of them to be in the sixth. This is an important fact in reconstructing our pedigree. Since no inbreeding as close as brother-sister mating occurred, it is possible to lay out a pedigree including this specified number of ancestors reappearing the number of times set forth above (see Figure 4). This must be fairly close to that actually existing, and shifting the ancestors around would not great-

ly alter the result. If the reviewer understands Dr. Shapiro's method the propositus of this "make-believe" pedigree has an inbreeding index according to his formula of 29 per cent, — quite close to the stated 25.56 per cent.

On the admittedly somewhat insecure basis of this "make-believe pedigree" we can make an approximate comparison between the two inbreeding indices, and a comparison which, considering the nature of the material may well give a result not departing very greatly from the true index. The result is a surprisingly low inbreeding coefficient by Wright's formula of 4.2 per cent for the person mentioned above. This means that the propositus of this pedigree is only 4.2 per cent more homozygous ("pure") in his genic constitution than an individual whose father and mother are not related. For purposes of comparison it might be noted that by this formula the child whose parents are first cousins is 6.25 per cent inbred while the offspring of a brother-sister mating (from parents not inbred) has an inbreeding coefficient of 25 per cent.

While an inbreeding coefficient of 4.2 per cent seems rather disappointingly small under the circumstances it is not as Dr. Sewall Wright points out wholly negligible in genetic significance. A four per vent decrease in heterozygosis means an equal apportionment of this fraction of the population to the two homozygous classes. This may mean a very substantial increase in the appearance of rare recessive types, since for rare genes, heterozygotes are much more numerous than homozygotes. For recessive genes with a *gene* frequency of one per cent, the frequency of recessive individuals is only 0.01 per cent under random mating but that of heterozygotes is 1.98 per cent. Apportioning four per cent of this figure equally to the two homozygous classes raises the frequency of recessive individuals nearly four-fold (0.036 per cent). If there were many genes of this sort in the English and Tahitian populations a considerable proportion would of course be wholly absent (even in hetrozygotes) in the small sample of mutineers and their wives with which the population started, but those present at all would show more than the average four-fold increase in occurrence with consequences which might well be important. Any additional inbreeding to the children or grandchildrn of the mutineers would increase the size of the homozygous classes proportionately.

This inbreeding coefficient of 4.2 per cent represents the extent to which the propositus is inbred with respect to the original mutineers and their wives. There may also be additional inbreeding to the children, or even to the grandchildren of the mutineers. Thus in the pedigree (Figure 4) if Y_1 and Y_5 in Generation II were the same person, and not brothers, there would be additional inbreeding to this individual. This would amount to only 0.2 per cent for each such duplication in Generation II, and to 0.8 per cent for each such common ancestor in Generation III. It is necessary if these individuals are to affect genetic inbreeding that they be on the "opposite side of the house," so that they appear as ancestors of both the father and mother of the propositus. Thus if C_2 were the same as C_3, the inbreeding coefficient of the propositus would be raised 0.8 per cent. The population was large enough so that such secondary inbreeding is not necessarily important. Thus the mutineers actually had about 25 surviving children and 24 are called for in this pedigree if there were no inbreeding to any of them. It would seem unlikely that all the children would be represented in one pedigree, so that some secondary inbreeding to children of the mutineers undoubtedly did occur. Ten additional secondary lines in Generation II would only raise the coefficient about two per cent, making the total inbreeding of the young man in question about equal to that of a child of first cousins.

A restricted ancestry has produced few ill effects. "Physically, the islanders are robust and healthy. Their

medical record is good, with no evidence of degenerative diseases peculiar to them. Abnormalities of physical structure are practically non-existent on Pitcairn. As for the birth rate, it is not incontestable that inbreeding has brought about the decline I have already mentioned. Other causes might more plausibly be evoked to explain it. The only general defect I know of among the Pitcairn islanders which may be attributed to inbreeding is the degeneration of their dentitions." In mental development the picture is much the same. Dr. Shapiro administered no psychological tests. While admitting a possible bias in favor of the islanders, the author speaks highly of their abilities. "Actually I knew of only two or three who were distinctly below par mentally—a small proportion in a group of two hundred. Several were dull but able to manage their affairs efficiently enough. The rest seemed to fit into the average range of intelligence. All in all, therefore, I can only conclude that inbreeding, as far as my evidence goes, has not caused degeneration among the Pitcairn islanders."

One other possible effect is noted in the large number of twins born among the Pitcairners. Between 1850 and 1934 nine twin births occurred among 320 births on the island. This gives a twin frequency of nearly three per cent, which is on a par with the other reproductive prodigies of the Pitcairners.

Arising as the group did from two very diverse cultures, it is interesting to observe which cultural patterns have survived in the social economy of the island dwellers today. Some 32 arts and amenities were studied by Dr. Shapiro with an idea of determining whether the Tahiti pattern or the English pattern had prevailed. Household arts, methods of building houses, arranging household furniture, fishing, agriculture, family social life, and religion were included in the list. Tahitian culture prevailed in a majority of the cases, though many English techniques also survived. A surprising number of original "cultural mutations" also were made. Thus among themselves "the Pitcairn Islanders speak a dialect incomprehensible to English and Polynesian ears." All of the Pitcairners today speak English in addition to this dialect, and we have on record the astonishment of the captains of early ships to touch on Pitcairn at the excellent English in which they were addressed by the Pitcairn youths who came out to greet them.

In a world which is becoming increasingly complicated in many ways it seems very doubtful whether ever again even an urge to plant introduction will make possible a human experiment so nearly perfect. We have much talk today of social experimentation, but the experiments almost always have bad beginnings, set up as they usually are to meet an emergency, and of their end usually the less said the better! A valid control is usually lacking, and so many variable factors enter in that we can never be sure of getting an unequivocal answer. Even on Pitcairn our experiment seems to need several generations more. If our "make-believe" pedigree discussed above is not too far from actuality it would seem that the foundation group was too large or the time has been too short for really intense human inbreeding to take place. Thus it seems that one involuntary objective of Captain Bligh's expedition has not yet been fully realized. Under the circumstances the only course seems to be to enjoy the *Heritage of the Bounty* to the full, and to withhold final conclusions until the full pedigrees are available for study. Fortunately Pitcairn Island is not easily reached, and those born there are content to stay, or if they wander, they generally return. Thus there is good reason to hope that our "experiment" will go on. Perhaps on another Christmas eve, in 2034 or in 2134, Dr. Shapiro's writings will inspire some other visitor to go back and find out what has been happening in the meantime to the genes of Christian, Young, McCoy, Quintal, Mills and Adams.

ROBERT COOK

THE INHERITANCE OF WHITE FACIAL MARKINGS IN ARABIAN HORSES

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Anderson[1] stated in 1914 that in order to learn something about the genetics of the horse we should start with a simple problem, namely, a study of the inheritance of the coat colors. The mode of inheritance of the different coat colors has been explained by several workers. Studies have also been made of other characters, such as the inheritance of white markings on the face and legs. The knowledge of the genetics of the horse has been summarized in the excellent review of Crew and Smith[2]; as is shown therein, the explanations arrived at by different authors do not always agree, and many points are still not satisfactorily explained. With the purpose of adding to the general fund of knowledge concerning the genetics of the horse, the present study, which is an attempt to explain the inheritance of the facial markings in the Arabian breed, was undertaken.

Sources

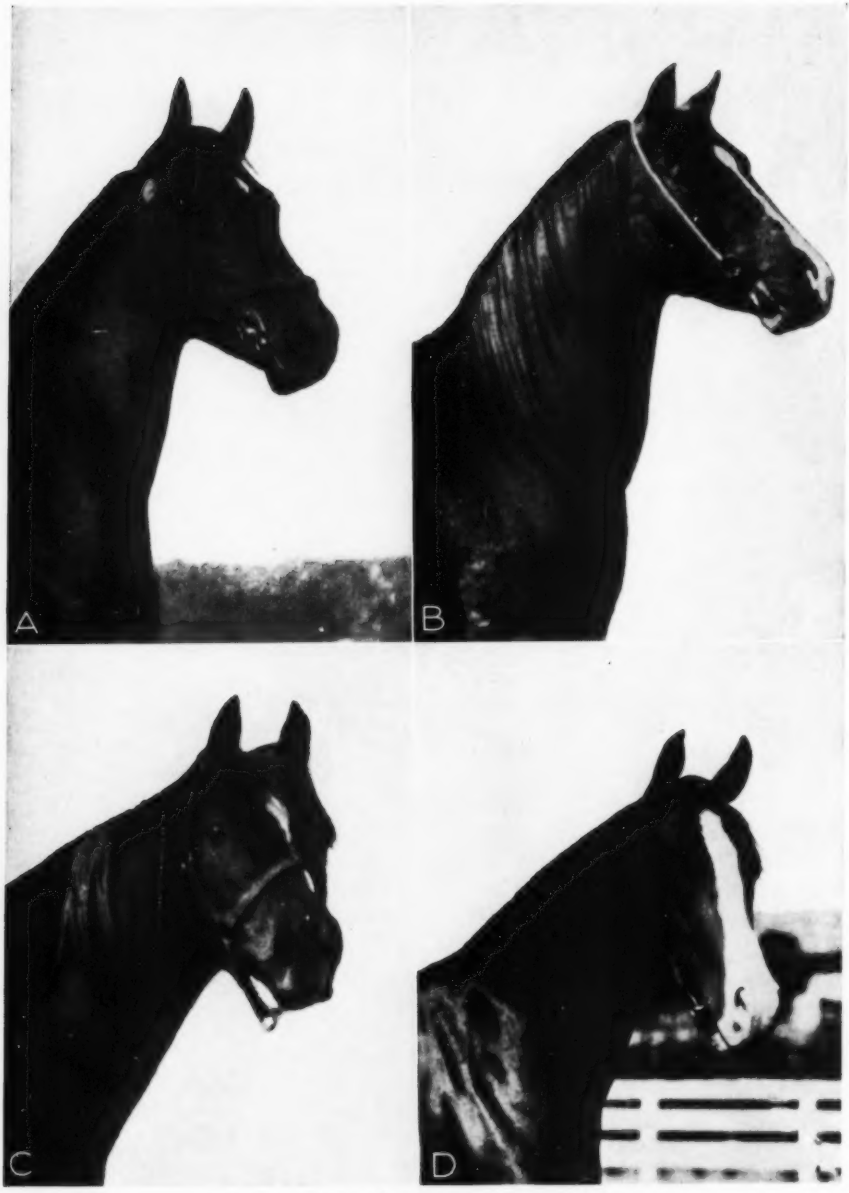
The data were obtained from the stud books of the Arabian Horse Club of America. Other workers have reported difficulties with stud-book data, and we can confirm these previous experiences. The data, thus tabulated, are subject to errors. The errors which we encountered are due to the fact that the markings of the several animals involved in the population studied were reported by many different individuals. In some instances the reported markings do not coincide with the actual markings on the horses, and in other cases the descriptions are ambiguous, due to the failure on the part of those registering horses to adhere to the definitions of the descriptive terms used in the stud books.

The authors have examined the markings on about 200 horses. Most of these are included in the present study. Through the kind assistance of some of the prominent breeders,* pictures of most of the other horses included in this study have been made available for our use. The facial markings of all but eight animals were thus checked, either by photograph or by actual examination of the animal.

Difficulty was also encountered in tracing the pedigrees of the animals. In a very few generations most of the pedigrees were traced back to desert bred animals or to animals imported from Europe. In the case of desert bred animals the name of the family to which the sire and dam belong is given rather than names and descriptions of animals. Most of the animals imported from Europe are registered in the General Stud Book, and descriptions of the markings are not given.

The offspring of 16 stallions and 130 mares, totaling 331 foals, were studied. Of the 130 mares only 29 had produced four or more foals. The fact that so large a proportion of the mares had such a small progeny made it impossible to distinguish between homozygous and heterozygous matings in most instances.

*Through the kindness of some of the prominent breeders, photographs and records of many of the horses included in this study were made available for our use. Mr. Peter B. Bradley loaned us his personal album of Arabian horse photographs. Mr. W. R. Brown sent us several photographs, as did the secretary of the Arabian Horse Club. Mr. H. H. Reese of the W. K. Kellogg Institute of Animal Husbandry gave us much aid during our visits with him, and placed his records at our disposal.



FACIAL PATTERNS OF ARAB HORSES

Figure 5

The photographs show some of the different positions which the facial markings may take. Farana 708 (*A*) bears a *star;* Antez 448 (*C*) has a *star* and *strip;* Mirzam 808 (*B*) and Shemseh 656 (*D*) both have a *star, strip, snip,* and *chin spot.* In *B* the chin spot is separate, while in *D* it is joined to the other markings.

In this paper the facial markings have been designated as *star, strip, snip,* and *chin spot,* depending upon the part of the face involved. Any white marking on the face above the eyes was called a *star*. *Strip* designated white marks from the eyes to the nostrils; *snip,* any white from the nostrils to the lip. Any white on the lower lip to the chin groove constituted the *chin spot.* The *star, strip,* and *snip* varied in size and shape. They occurred singly, in twos or threes, joined together or separated. The *chin spot* also varied widely in size and shape. Many times it appeared on only one side of the lower lip as a small white mark. In other cases it covered the whole chin. It rarely occurred on a horse which did not have some one or more of the *star, strip,* and *snip* markings. It might be well to add that the greatest error encountered in the stud books occurred in the classification of *chin spot.* About a dozen pictures were found in the stud books of horses which showed a chin spot but whose descriptions gave no indication of its presence. The accompanying figures show the location and variations in the patterns studied.

It was suspected immediately that *chin spot* was inherited in a different manner than were *star, strip,* and *snip,* since it was observed to occur with much less frequency than other markings. The data were, therefore, analyzed in several different ways. The facial markings were first considered as a whole, then the patterns were broken up and studied in groups and as individual patterns.

Experimental

Munckel[7,8] states that white markings in horses are due to a special dominant factor independent of coat color and that other factors, even a suppressor, affect the distribution, size, and shape of the white pattern. Crew and Smith list a dominant factor *M* for white markings with further modifying factors affecting this general factor.

The results of this paper are in close agreement with the findings of Munckel, and of Crew and Smith. Table I shows the distribution of the face markings in the population studied. It is seen that the *star-strip-snip* combination occurs more frequently than does any single pattern. Fifty per cent of the population as described in Table I is included in the two groups—*star-strip-snip-chin spot* and *star-strip-snip*. The chin spot appeared in only 100 or less than one-fourth of the 477 animals studied. In only one case did it constitute the only marking. It should also be noted that the frequency with which the individual patterns appear depends upon the position on the face. More white markings are found on the upper portions of the face than on the lower; e.g., there are more *stars* than *strips, snips,* or *chin spots;* likewise there are more *strips* than *snips* and *chin spots* and more *snips* than *chin spots.* When two patterns are considered together, however, the *star-snip* combination is most frequently observed.

Table II gives the distribution of the facial markings in the various matings. Whenever two animals bearing *chin spot* either alone or in combination with some other pattern were mated together, the offspring, with seven exceptions, bore *chin spot* along with some other pattern. These seven exceptions are the animals about which doubt exists regarding the accuracy of their reported markings. Table II shows also that *chin spot* occurs in some of the progeny in most of the matings even when the stallion and mare do not show it. In fact there were only two stallions none of whose get showed *chin spot*. Contrary to the behavior of the *chin spot,* the *star, strip,* and *snip* patterns are not found in the offspring unless they are present in one or both of the parents.

The genetic composition of all the parents has not been completely determined. In those instances where the genetic composition of the parents has been established the numbers in any one mating are too small to fit any definite ratios. In spite of these limitations the evidence seems to point strongly toward the belief that the chin spot

behaves as a recessive and that the *star-strip-snip* pattern, as well as units of this pattern, behave as dominant characters.

An analysis of the pedigrees of some of the animals strengthens these beliefs. About fifty pedigrees were traced back to the fourth generation. Descriptions were available through the third generation for many of these animals, and in a few cases descriptions of animals in the fourth generation were given. The *chin spot* was frequently observed to skip a generation and then reappear even though neither parent showed the character. The other patterns, *star*, or *strip*, or *snip*, on the other hand were always found in the parents when they were present in the offspring. Sometimes the *star*, or *strip*, or *snip* were present in the parents and not in the offspring. If this happened, the pattern apparently did not reappear among the descendants until an animal bearing the pattern in question was mated to a non-white animal.

In Table III the data have been regrouped disregarding the presence or absence of the chip spot. The mating, *star-strip-snip* × *star-strip-snip* shows a preponderance of offspring having this pattern. This is characteristic of all matings involving the *star-strip-snip* pattern. In the mating *star-strip-snip* × *star* there is also an excess of animals bearing a star alone.

Table I. Distribution of Face Markings in the Population Studied*

Face Markings*	Stallions	Mares	Offspring
S St Sn Ch	4	14	65
S St Ch			5
S Sn Ch			2
St Sn Ch		4	1
S Ch			1
St Ch			1
Sn Ch			1
S St Sn	9	39	110
S St		3	15
S Sn	1	15	40
St Sn		5	10
S	1	20	41
St		7	25
Sn	1	3	5
Ch		1	1
None		19	19
Total	16	130	341

Table II. Distribution of Face Markings in the Various Matings (In these Tables S = star, St = strip, Sn = snip, and Ch = chip spot.)

Mating	No.	Resulting patterns: S St Sn Ch	S St Ch	S Sn Ch	St Sn Ch	S Ch	St Ch	Sn Ch	S St Sn	S St	S Sn	St Sn	S	St	Sn	Ch	None
S St Sn Ch x S St Sn Ch	12	7	1						3*		1*						
S St Sn Ch x S St Sn Ch	1	1															
S St Sn Ch x St Sn Ch	5	2							1*		1*		1*				
S St Sn Ch x S St Ch	3	2															
S St Sn Ch x S St Sn	41	15					1		13	1	4	1	2	5		1	
S St Sn Ch x S St	2	1										1					
S St Sn Ch x S Sn	8	6									1	1					
S St Sn Ch x St Sn	2								2								
S St Sn Ch x S	34	3	1						13	2	4	1	4	3		3	
S St Sn Ch x St	11	2							6		2			1			
S St Sn Ch x Sn	9	1							5		1	1		1			
S St Sn Ch x None	29	4		1					15		3		2	3	1		
S St Sn x S St Sn Ch	1								1								
S St Sn x S St Sn Ch	5	3									2						
S St Sn x S St Sn	41	2	2		1			1	16	4	5	2	3	1			
S St Sn x S St Sn	3	2	1						2								
S St Sn x S St Sn	29	3							7	2	5		5	4		1	2
S St Sn x S St Sn	3								1		1						1
S St Sn x S	40	2							12	3	7		1	13	1	1	
S St Sn x St	10	2							7					1			
S St Sn x Sn	10			1					3		4				1	1	
S St Sn x Ch	2								1						1		
S St Sn x None	15	2							2	1	1		2	5			2
S St x S	1										1						
S St x St	3												1	2			
S St x None	1												1				
S x S	4												3	1*			
S x Sn	2					1					1						
S x None	2														2		
St x None	2																
Sn x None	2																
Total	331	65	3	2	1	1	1	1	110	13	40	10	41	25	3	1	10

*These are the eight animals on which the facial markings were not checked. They appear in the following tables but are unmarked.

Table III. Distribution of Face Markings in Star, Strip, Snip Matings

Mating	No.	Resulting patterns: S St Sn	S St	S Sn	St Sn	S	St	Sn	None
S St Sn x S St Sn	65	41	0	4	6	5	7	1	1
S St Sn x S St	6	5			1				
S St Sn x S Sn	20	17	2	0	1	0	4		2
S St Sn x St Sn	16	9	1	2		1	2		1
S St Sn x S	74	20	6	11	2	17	4	1	3
S St Sn x St	21	17		2		1	1		
S St Sn x Sn	19	9		6	1		1	1	1
S St Sn x none	49	27	1	0	2	7	4	1	2
S Sn x St	3					1	2		
S Sn x none	1					1			
S x S Sn	1			1					
S x S	4					3	1		
S x Sn	2			1		1			
Sn x none	2							2	

Table IV. Distribution of Single Patterns

Mating	No.	Star	No Star
S x S	119	106	38
S x No S	110	91	19
No S x No S	2		2
		Strip	**No Strip**
St x St	138	117	21
St x No St	125	115	68
No St x No St	10	1	9
		Snip	**No Snip**
Sn x Sn	147	106	41
Sn x No Sn	160	128	32
No Sn x No Sn	4		4
		Chin Spot	**No Chin Spot**
Ch x Ch	21	14	7
Ch x No Ch	150	44	106
No Ch x No Ch	190	56	134

The last six rows of Tables II and III show the segregation of the face patterns when only some of the patterns are present in the parents. While the numbers produced by each type of mating are small, the results strengthen the belief that *star, strip,* and *snip* are dominant characters and *chin spot* is a recessive character.

Following the lead of the last six rows of Table III the data were analysed, considering only two of the face patterns at a time. The fit between the observed and calculated ratios was poor; nevertheless evidence is found which strengthens the hypothesis advanced in the preceding paragraph.

If the patterns are considered individually as is done in Table IV, a striking distribution is found. Further evidence of the recessive nature of the *chin spot* character is seen in the fact that there are approximately as many animals with a *chin spot* as there are without a *strip* or *snip*. Furthermore, the number of animals without a *chin spot* is approximately equal to those with a *strip* or *snip*. Considering the *star-no-star* group, more animals are found bearing a *star* than are found in the *strip, snip,* or *no chin spot* groups. The number of animals without a star is in close agreement with the number found in the *no-strip, no snip,* and *chin-spot* groups.

Most animals are registered before they are a year old, and as a result the chin spot is often not included in the description required upon the application for registration. Unless the spot covers a large part of the chin, it escapes the attention of the owner, or is not thought to be an important mark of identification. It is believed that the seven animals lacking a chin spot, in the matings of *chin spot* × *chin spot,* fall into this category. It is not possible to ascertain the number of animals in the other categories which actually carry a chin spot and yet do not have it recorded in their registry description.

Discussion

Since no piebald Arabian horses have been registered and since the pattern does not appear in the breed or in either fact or legend, it may be safely assumed that it is not present in Arabian horses. The presence of white on the face is possibly an expression of the highest grade of pigmentation of the piebald pattern. Klemola[4] reports a dominant spotting ("Pied") factor in certain breeds and a recessive spotting factor ("Splashed White") in other breeds. The recessive spotting factor and the wall-eyed condition apparently form an allelomorphic series. Both of these factors cause white spots to appear in the coat. The first regions of the coat to lack pigment are located on different parts of the body, and the regions which retain pigment longest are likewise different. Munckel finds only a dominant form of spotting. In general he noted a relationship between the spotting exhibited by the parents and that found in the offspring. Munckel also states that the "cold-blooded" breeds exhibit the patterns containing the most white, and that the Arabian and Thoroughbred breeds exhibit the least white.

The Arabian breed apparently carries quite generally the white marking factor *M* of Crew and Smith. The factors which produce the *star, strip, snip,* and *chin spot* are seemingly modifiers of the *M* factor. The size and shape of these patterns depends upon the influence of still other unknown factors. With the present data it was not feasible to try to study the relationship between the amount of white exhibited by the parents and that shown by the offspring.

It is possible that the factors governing the facial markings may act as either extensors or suppressors of basic pattern factors. Should this be the case they must, nevertheless, act as either dominant or recessive genes. In the data presented above merely the dominant or recessive nature of the factors has been considered since it was impossible to find a simple basic pattern without breaking up the facial markings into four distinct patterns.

A question might be raised as to whether the various patterns represent

an allelomorphic series. The results of two series of matings, of the stallion Hamrah No. 28* with two mares, cast serious doubt on this possibility. The mare Meleky No. 63 (*star*) produced ten offspring by the stallion Hamrah No. 28 (*star-strip-snip-chin spot*). One of the offspring was *star-strip-snip-chin spot;* two were *star-strip-snip;* two were *star-snip;* three were *star;* one was *snip;* and one had no face markings.

Dahura No. 90 (no facial markings) produced eight offspring by Hamrah No. 28. One of the eight offspring was like the sire; five were *star-strip-snip;* one was *star-snip-chin spot;* and one was *star.*

If the face markings were allelomorphic a maximum of four different face patterns would be expected to appear in any one mating. In the first case cited above six different facial markings were produced. In the second mating four classes were produced where only two were expected. This seems strong evidence that we are not dealing with an allelomorphic series.

The results of the different matings do not closely fit definite mendelian ratios. This may be accounted for by the fact that the data contain inherent errors which it has been impossible to evaluate with much accuracy. The error present in herd book records has been estimated to be about three per cent for sex distribution in hogs (McPhee[6]) and five per cent for color classification in the coat colors of horses (Heizer[3]). When we deal with white markings covering a small area, the error is probably greater. Breeders, when registering horses, often fail to mention the presence of a white mark whereas they seldom indicate a white marking where none is present. An example of this is Shemseh No. 656. In the stud book she is stated to have a blaze; actually in addition to the blaze her whole chin is white (Figure 5*D*). By conservatively estimating the error to be five per cent and using this figure as a correction factor the results of each part of Table IV closely fit the expected 3:1 ratio.

That most of the parents are heterozygous is seen from Table IV. In the *star* × *star* and *strip* × *strip* matings, eighty-five per cent of the offspring in each group had a star or strip respectively. In the *no chin spot* × *no chin spot* mating eighty-four per cent of the offspring lacked a chin spot. The *snip* × *snip* mating is the most heterozygous as only seventy-five per cent of the offspring show a snip.

Since the tables accompanying the paper have, for the most part, been constructed around the sixteen stallions studied, it was hoped that an analysis of those mares having produced several offspring might prove enlightening. By working upon the hypothesis that the various patterns were inherited independently, an attempt was made by means of Warwick's "Probability Tables for Mendelian Ratios with Small Numbers"[9] to construct the genotype of the several mares and also of the stallions. The results show that apparently ten mares were homozygous for the star pattern. If we subtract the produce of these mares from the *star* × *star* class in Table IV the result is a statistically significant 3:1 ratio. The same procedure was followed for *strip, snip,* and *chin spot.* No individuals were found which were homozygous for the *snip* pattern. Treating the *strip* × *strip* and *no chin spot* × *no chin spot* matings as the *star* mating was treated, the resulting ratios very closely approximate the expected 3:1 ratios. The value of the deviation divided by the probable error was 3.3 in each case. There were several mares in each mating whose pattern was questionable, so that the results must be taken as merely suggestive.

Summary

A study of the facial markings in a population of 477 Arabian horses indicates that the *star, strip, snip,* and *chin spot* patterns are conditioned by modi-

*The number after the animal's name is the registration number given in the stud book.

fying factors of a general factor for white markings (the *M* factor of Crew and Smith). The *star, strip,* and *snip* patterns seem to be inherited as dominant characters while the *chin spot* appears to be a recessive character.

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Books Received

***BOOKS** are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the* JOURNAL *will be reviewed in later numbers.*

MEN, MONEY AND MOLECULES, *by* William Haynes, Publisher "Chemical Industries." Pp. 214. Garden City, New York: Doubleday, Doran & Co., 1936.

NEUE ERGENNISSE DER ZWILLINGSFORSCHUNG BEIM RIND, von C. Kronacher, Berlin-Dahlem unter Mitarbeit von D. Sanders, Mit 205 Abbildungen und 28 Kurven. Pp. 172. Price, Rm. 10. Berlin: Verlag von Paul Parey, 1936.

J. ARTHUR HARRIS, Botanist and Biometrician. *Edited by* C. Otto Rosendahl, Chairman of the Department of Botany, University of Minnesota, Ross Aiken Gortner, Chief of the Division of Agricultural Biochemistry, University of Minnesota, and George O. Burr, Professor of Botany, University of Minnesota. Pp. 209. Price, $2.50. Minneapolis: University of Minnesota Press, 1936.

MEDICAL HISTORY OF CONTRACEPTION, *by* Norman E. Himes, Ph.D. Medical Foreword by Robert Latou Dickinson, M.D., F.A.C.S. Pp. 521. Price, $7.00. Medical Aspects of Human Fertility Series, Issued by the National Committee on Maternal Health, etc. Baltimore: Williams and Wilkins Co., 1936.

INDUSTRIAL AMERICA, Its Way of Work and Thought, *by* Arthur Pound. With illustrations. Pp. 234. Price, $2.50. Boston: Little, Brown and Company, 1936.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING, Thirtieth Annual Report. New York, 1935.

ANNUAL REPORT OF THE GENERAL EDUCATION BOARD, 19-341935. Pp. 105. New York, 1936.

CREATIVE RE-EDUCATION, *by* Frederick Peterson, M.D., LL.D. Pp. 112. Price, $1.00. New York: G P. Putnam's Sons, 1936.

NATURE IN THE WILD—A Selection of the World's Finest Photographs. Pp. 96. Price, $2.00. New York: Charles Scribner's Sons, 1936.

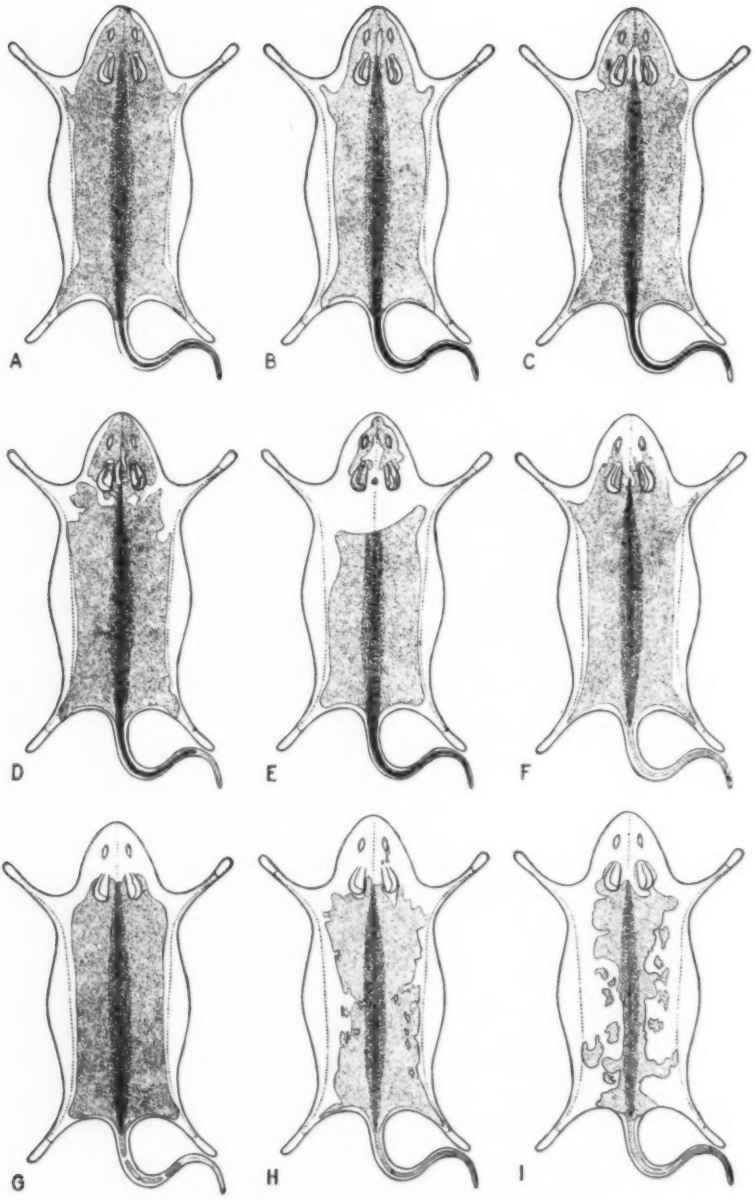
FAMILY BEHAVIOR, A Study of Human Relations, *by* Bess V. Cunningham, Ph.D. Pp. 471. Price, $2.75. Philadelphia and London: W. B. Saunders Company, 1936.

HOW ANIMALS DEVELOP, by C. H. Waddington, Laboratory of Experimental Zoology, Cambridge University. Pp. 127. Price, $2.00. New York: W. W. Norton & Co., 1936.

VOM WILDTIER ZUM HAUSTIER, *by* Hans Nachtsheim. Pp. 116. Alfred Metzner Verlag. Berlin, 1936.

ANNALES DES EPIPHYTIES ET DE PHYTOGENETIQUE, Organ des Stations et Laboratoires de Recherches. Pp. 392. Paris: Imprimerie Nationale, 1936.

PSYCHOLOGY OF SEX, *by* Havelock Ellis. Pp. 337. Price, $3.00. New York: Emerson Books, Inc., 1935.



VARIATION IN PIEBALD DEER MICE

Figure 6

Diagrams representing the several degrees and types of white areas which occurred in Peromyscus and which were used in the classification of the mice. The diagrams were drawn from skins of animals typical of arbitrary but well defined types of distribution and area. The various types are not separated by equal percentages of white, for it may be seen that the lower grades show less variation than the higher. *A* represents a mouse with no unusual white areas. *B*, *C*, *D* and *E* are types of piebald in the *rufinus* stock. *F* and *G* are types of the *bairdii* stock. *H* and *I* are two of the lower grade types occurring after the *rufinus* and *bairdii* types were crossed. A few totally white mice with black eyes also resulted from this cross.

PIEBALD CHARACTERS OF THE DEER MOUSE*

HORACE W. FELDMAN

Hyde Park, Massachusetts

THE occurrence of white areas in an otherwise colored pelage of mammals is a very common variation. In birds, also, white portions of the plumage are frequent in a wide variety of species. Such white spotting or piebaldness is usually found to be hereditary, although a considerable variability exists in the shape and extent of the white areas; this variability is due to non-hereditary influences upon the development of the integument. The deer mice, genus Peromyscus, have at this writing supplied a number of reported cases of white spotting. Castle and Phillips[2] found that, by selection and inbreeding, a white band on the tail could be extended to cover a large part of the abdomen in *Peromyscus leucopus*. The white pattern was recessive in heredity. Sumner[3] observed white spots on the head in several races of Peromyscus. A white tip of the snout in *P. maniculatus rubidus* was probably a recessive variation. Barto and Heustis[1] investigated white stars in two subspecies of *P. maniculatus—gambeli* and *rubidus*, and in hybrids of these two races. The white areas were of various shapes and varied in extent from a few white hairs to patches one and one-half centimeters long. In heredity the star was recessive but appeared in fewer individuals in all types of matings than would have been expected. A positive correlation was observed between large stars of parent mice and large and frequent stars in the offspring. The authors concluded that several genes produced this variation.

Since 1928 a number of piebald and white star types have appeared in Peromyscus colonies at the University of Michigan.† The northern white-footed mouse, *P. leucopus noveboracensis*, supplied a small white star on the head, with an occasional mouse showing a shortened tail stripe. The white areas varied from a few white hairs to a stripe about a centimeter in length and three millimeters in width. The variation behaved as a mendelian recessive character. Similar white areas were observed in several races of the deer mouse, *P. maniculatus-gambeli, sonoriensis, blandus* and *rufinus*. The white spotting was not investigated at length in the first three of these although the character showed in *blandus* a great variability capable of distinct alterations under selection. In this respect the *blandus* white spotting resembled the *rufinus* material, which was examined at some length. Two distinct stocks of *P. m. rufinus* were studied with respect to white spotting. One from Buena Vista, Colorado, had a small white star on the face and a whitish tip of the nose. Ratios from matings indicated that each variation was inherited as a separate mendelian

*A contribution from the Laboratory of Vertebrate Genetics, University of Michigan. Grants from the Faculty Research Fund supported this work in 1928 and 1929.

†Doctor Lee R. Dice supplied most of the foundation animals from which the material discussed in this paper was reared. The very striking and interesting character in the white-footed mouse, *P. maniculatus bairdii*, was furnished by Doctor Elmer Roberts. The writer is grateful to these two workers for the material. It is a pleasure to acknowledge the valuable assistance of Miss E. Lucile Beerbower, Research Assistant in Vertebrate Genetics, in taking notes on these mice and in making the diagrams which accompany this paper.

recessive character. The piebald character of the second stock of *rufinus* was typical of the variation as it had appeared in the several races of Peromyscus. This particular stock was used for more extensive observations because it was more fertile in the laboratory than the others. It originated from three females and one male caught near La Veta, Colorado.

A distinct type of piebald appeared in two females of *P. maniculatus bairdii* captured near Morrison, Illinois. The white areas were very similar in size and shape on these two sisters and showed a distribution which differed from any observed in the above races. They embraced most of the face, neck and chest. The tail stripes were also incomplete. A further difference between this and the other types of piebald was the lack of a sharp demarcation of the white areas from the colored. A strip of fur about four millimeters wide in which white and colored hairs were mixed bordered the white areas.

Breeding Results

A total of 1,720 mice were observed in breeding tests on the nature of the piebald characters in the La Veta stock of *rufinus* and the *bairdii* stock. The results of observations upon the *rufinus* types gained by matings within the race are presented in Table I. Results of the matings within the *bairdii* race are summarized in Table II. In Table III are given the results obtained from crossing certain types of piebald *rufinus* and piebald *bairdii*.

Within the *rufinus* race the piebald appeared as a character having great variability. The original mice with white stars (Figure 6, *B* and *C*) proved to be of three genetic types. Two of the types bred true and were recessive to self. The third produced *inter se* definite proportions of self stars, and a much higher grade piebald in which the white areas included a collar or band of white about the neck. The types having markedly incomplete bands did not breed true but produced offspring with complete bands, incomplete bands, and stars in definite ratios. In this respect they resembled the exhibition type of "Dutch" rabbit and belted house mouse. The form with a complete band bred true in all cases. In crosses between it and homozygous self mice the F_1 consisted of star individuals. These produced an F_2 of approximately equal proportions of bands, stars, and self individuals. The F_1 back-crossed to the banded type gave bands and stars in approximately the ratio of 3:1. On the banded individuals the complete and incomplete collars appeared in the ratio of 1:2. When the F_1 stars from band $\times$ self were back-crossed to self mice they produced stars and selfs in the ratio of 1:3.

The genetic behavior of the piebald of this stock of *rufinus* lends itself readily to a mendelian interpretation. The results of the breeding tests point to the existence of two recessive piebald factors which interact in the extension of white areas in the pelage of the mice. Self mice are $P_1P_1\ P_2P_2$. True breeding star types are either $P_1P_1\ p_2p_2$ or $p_1p_1\ P_2P_2$, and the other star type is $P_1p_1\ P_2p_2$. Incompletely banded mice are either $P_1p_1\ p_2p_2$ or $p_1p_1\ P_2p_2$. The animals with complete bands are thus the double recessive $p_1p_1\ p_2p_2$. In all types there is a slight tendency for less white to appear in certain individuals than is typical of the genetic formula. Genetically, star mice which do not show any white hairs are the most common cases of this overlapping in development.

The piebald character which appeared in the *bairdii* was very uniform and simple in mode of inheritance as compared with that of *rufinus*. It has been termed "white-face" because of the similarity to the familiar character of Hereford cattle. The original females when mated to self mice of their race produced progeny, half of which were self and half white-faced like themselves. It was found that piebald mice in this stock were of two genetic types. One produced only white-faced

young in matings with white-faced and with self animals. The other, like the original females, produced both piebald and self young when mated *inter se* and with self animals. True breeding white-faced mice mated with self mice produced an F_1 generation which was entirely white-faced. These produced an F_2 consisting of white-faced and self individuals in the ratio of 3:1. Several F_1 mice were mated to self animals and thereby had white-faced and self progeny in equal proportions. Self F_2 segregates *inter se* produced only self offspring. These results indicate that the piebald in this stock of *bairdii* was due to a mendelian factor which was completely dominant over self. It has been designated *S*.

After preliminary observations were completed upon the *rufinus* piebald character and upon the *bairdii* white-face it was deemed of interest to combine the two and thus study them in a common stock. Accordingly two crosses were made between them. Homozygous star *rufinus*, p_1p_1 P_2P_2, were mated with homozygous white-faced *bairdii*, *SS*. The F_1 consisted of white-faced mice. The F_2 was composed of four types: self, star, white-faced, and a new form in which the head, neck, under side, and portions of the sides of the mice were white. These occurred in proportions close to the dihybrid ratio of 3:1:9:3. When F_1 mice were back-crossed to the star type these four types appeared in the progeny in approximately equal numbers. Homozygous banded *rufinus*, p_1p_1 p_2p_2, were also crossed with homozygous white-faced *bairdii*, *SS*. In this case the F_1 consisted of the extended white-face which appeared in the F_2 and back-cross generations of the above cross. These produced an F_2 of seven types; namely, self, star, bands, white-faced, extended white face, a new type of piebald in which only the mid-dorsal region and irregular areas on the sides retained color, and totally white animals. When F_1 mice were back-crossed to the banded type their progeny consisted of these seven types in proportions different from the F_2 generation, however.

An analysis of the results of these two crosses denotes in the first a dihybrid and in the second a trihybrid cross. The recessive factors of *rufinus* interact with the dominant of *bairdii* to produce cumulative effects on the extension of white areas over the pelage of the mice. The new types which appeared in the F_2 and back-cross generations may be explained as being due to the following genetic constitutions: extended white-face, *SS* or *Ss* with two of the recessive factors; restricted color, *SS* or *Ss* with three recessive factors; and totally white, $SSp_1p_1p_2p_2$ and Ss $p_1p_1p_2p_2$. A limited progeny from two completely white F_2 mice mated to banded mice indicated that in these two individuals we actually had a representative of each type. The offspring of one were all white and of the other white and banded in equal proportions. These results coupled with those from the intra-racial matings explain the heredity of piebald as it has appeared in the two races. By means of the dominant white-face factor and the two recessive star factors, a series of piebald types is produced ranging from self coloration in which there are no white dorsal areas to a completely white-coated, black-eyed form. It is obvious that the dominant factor was peculiar to *bairdii* and the recessives to *rufinus*. The observations upon this material suggest that the several regions of the pelage of Peromyscus differ in the susceptibility to loss of pigmentation. The region of the face between the eyes, the chest, and the tail are first to lose pigment. The chin and neck follow. An extension of all regions precedes the final stage of color elimination. The mid-dorsal region of the body is thus the last to retain color.

Summary

Piebald in a stock of *Peromyscus maniculatus rufinus* was due to two recessive mendelian factors which interacted to produce a range of types. Pie-

bald in a stock of *P. maniculatus bairdii* was caused by a single dominant mendelian factor. Crosses between the two races extended the variability to include completely white mice with black eyes.

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Table I. Summary of matings of piebald types in Peromyscus maniculatus rufinus, La Veta stock.

Types of Parents	Types of Offspring				
	Comp. Band	Incomp. Band	Stars	Self	Total
Complete Band inter se ($P_1P_1P_2P_2$)	35	0	0	0	35
Incomplete Band inter se ($P_1P_1P_2P_2$ and $P_1P_1P_2P_2$)	33	70	34	0	137
Stars inter se ($P_1P_1P_2P_2$ and $P_1P_1P_2P_2$)	0	0	87	2	89
Complete Band ($P_1P_1P_2P_2$) × Self ($P_1P_1P_2P_2$)	0	0	30	3	33
F_1 Stars inter se ($P_1P_1P_2P_2$)	6	36	57	55	156
F_1 Stars ($P_1P_1P_2P_2$) × Complete Band ($P_1P_1P_2P_2$)	24	50	28	0	102
F_1 Stars ($P_1P_1P_2P_2$) × Self ($P_1P_1P_2P_2$)	0	0	6	23	29
Stars ($P_1P_1P_2P_2$ and $P_1P_1P_2P_2$) × Self ($P_1P_1P_2P_2$)	0	0	0	29	29
F_1 Self inter se ($P_1P_1P_2P_2$ and $P_1P_1P_2P_2$)	0	0	11	42	53

Table II. Summary of matings of piebald types in P. m. bairdii.

Types of parents	Types of offspring		
	White-face	Self	Total
White-face (ss) inter se	27	0	27
White-face (ss) × Self (ss)	44	0	44
F_1 White-face (ss) inter se	92	30	122
F_1 White-face (ss) × Self (ss)	50	51	101
F_2 Self segregates (ss) inter se	0	38	38

Table III. Summary of matings of piebald Peromyscus maniculatus rufinus with piebald P. m. bairdii.

Types of Parents	Types of Offspring							
	Total-ly white	High grade body	Low grade body	White-face	Bands	Star	Self	Total
Band ($ssP_1P_1P_2P_2$) × White-face ($SSP_1P_1P_2P_2$)	0	0	36	3	0	0	0	39
F_1 ($SsP_1P_1P_2P_2$) inter se	2	37	59	47	13	24	16	198
F_1 ($SsP_1P_1P_2P_2$) × Bands ($ssP_1P_1P_2P_2$)	7	22	56	35	89	63	34	249
Star ($ssP_1P_1P_2P_2$) × White-face ($SSP_1P_1P_2P_2$)	0	0	0	29	0	0	0	29
F_1 ($SsP_1P_1P_2P_2$) inter se	0	0	19	53	0	8	20	100
F_1 ($SsP_1P_1P_2P_2$) × Star ($ssP_1P_1P_2P_2$)	0	0	22	25	0	26	39	112

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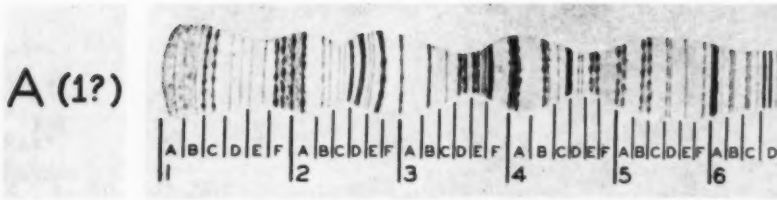
A Survey of Forest Genetics

The survey of plant and animal genetics which forms the main part of the 1936 Yearbook of the U. S. Department of Agriculture is to be continued in later issues, according to an announcement of the U. S. Forest Service. Next year it is planned as a part of this program to bring together all existing material on forest genetics. The Division of Silvics of the U. S. Forest Service is conducting this survey. A questionnaire has been prepared and circulated to all individuals and institutions known to be interested in this subject or doing work along this line. In a pioneer venture of this kind it is not easy to cover the field completely, and every reader of the Journal who has information or knows of work that should be included in this summary is requested to communicate with the editor or with Mr. E. N. Munns of the U. S. Forest Service at Washington.



Supplement to *Journal of Heredity*, Vol. 27, No. 8, August, 1936 (To follow Page 304).
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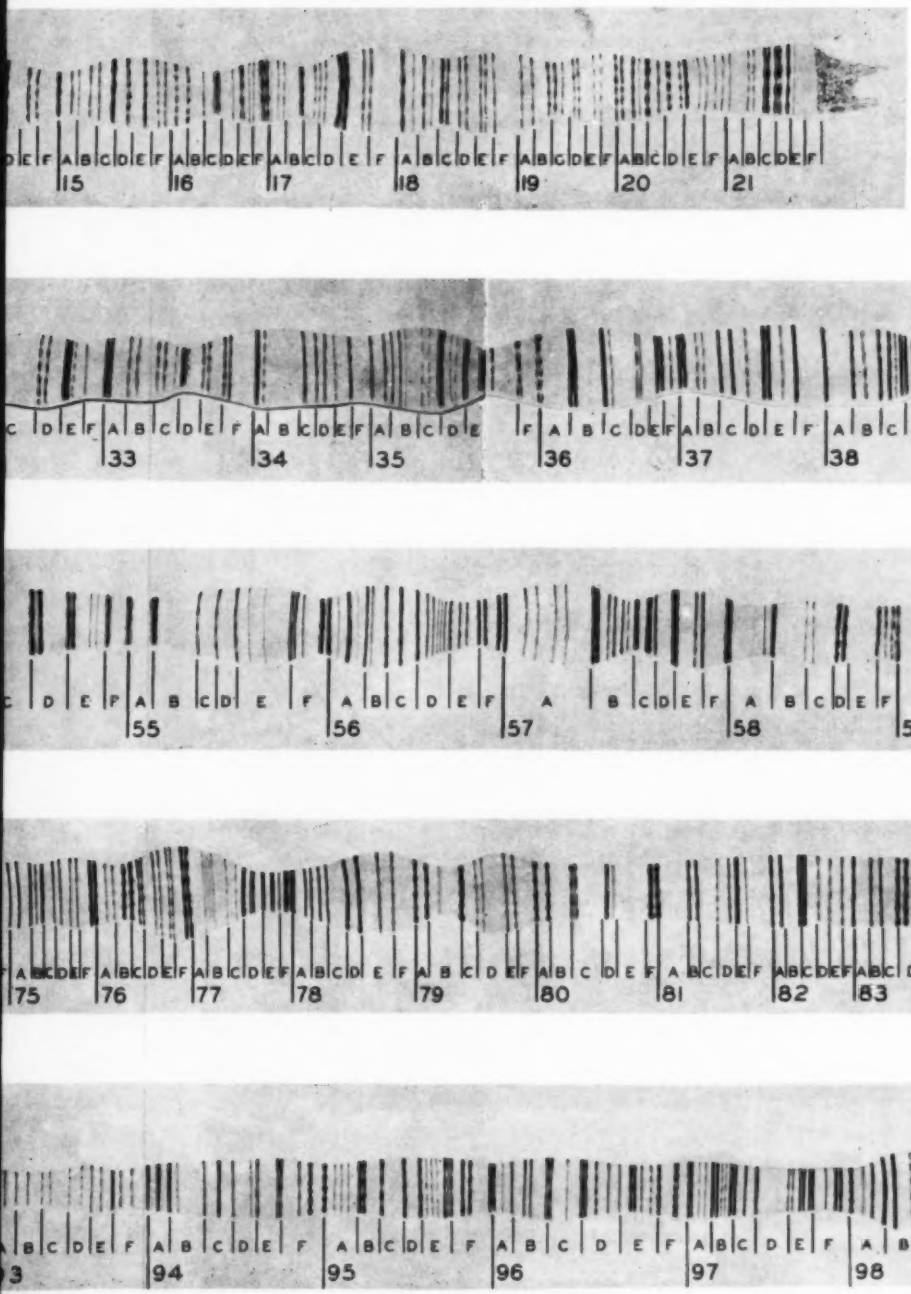
w Page 304).

REFERENCE MAP OF THE SALIVARY



HE SALIVARY CHROMOSOMES OF DROSOPHILA VIRILIS

Figure 7

SALIVARY GLAND CHROMOSOMES OF DROSOPHILA VIRILIS

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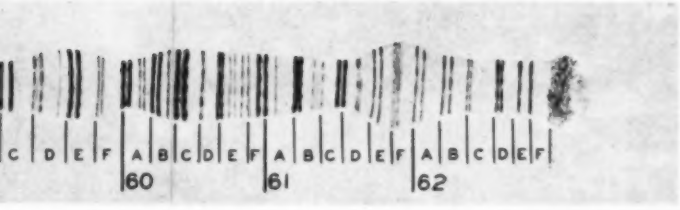


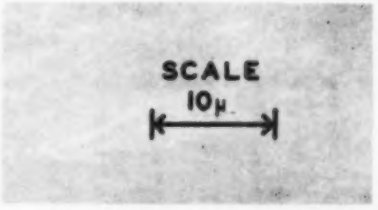
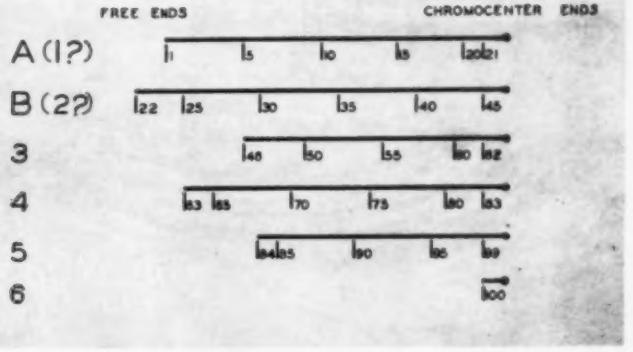


DIAGRAM OF SALIVARY CHROMOSOMES
SHOWING SCHEME OF MARKING



THE MORPHOLOGY OF THE NORMAL SALIVARY CHROMOSOMES OF *DROSOPHILA VIRILIS*

ROSCOE D. HUGHES

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INVESTIGATIONS of the genetics of *Drosophila virilis* are being conducted at the present time in several laboratories widely separated from each other. It need hardly be mentioned that a cytological analysis of the salivary chromosomes has become almost a necessity in such studies, and the present preliminary paper is offered with that fact in mind. It is admittedly a mere beginning in the cytogenetic analysis of *D. virilis*, but the identification of the various regions with genetic factors is merely a question of time. *D. virilis* lends itself exceedingly well to such a study because of the excellent staining qualities of the chromosomes and the rapidly growing data on linkage.

The aceto-carmine method of staining salivary glands of larvae just before pupation was used throughout, and in the microscopic work a 120× apochromatic objective and 10× compensating ocular were employed. The light source was a 6-volt ribbon filament lamp with various Wratton filters, chiefly 58A.

Metz[2] has shown that in *D. virilis* the diploid number of chromosomes is six pairs. In the gonial metaphase plate these consist of five pairs of rod-like chromosomes of approximately equal size and one pair of small, dot-like chromosomes. As might be expected, therefore, the salivary cells show six elements attached to a common chromocenter, pairing of homologous chromosomes occurring as in other species.

The drawings were made only from well-stained, uncoiled and moderately stretched chromosomes, and only from temporary mounts. In general the type of banding is very similar to that found in the salivary chromosomes of *D. melanogaster* by Painter,[3] Bridges,[1] and others. It is noted that the bands have a great tendency to occur in pairs, and usually, on closer examination, a heavy band is usually made up of two or more bands. In my best preparations the bands are predominantly of the broken type. Also, like *D. melanogaster*, *D. virilis* chromosomes show definite and fairly constant constrictions, which are an aid in identifying certain chromosomes when their ends, the most reliable and conspicuous criterion of their identity, do not lie in a clear area. These constrictions can be greatly distorted by extreme stretching. The lengths of the chromosomes vary considerably, since by undue pressure on the cover slip individual members can be stretched to twice or more their "normal" length. An attempt was made to measure and to obtain an average of the lengths of moderately stretched chromosomes. The approximate lengths are as follows: A (1?) = 230μ; B(2?) = 260μ; 3rd = 190μ; 4th = 220μ; 5th = 185μ; 6th = 12μ. The total length of all the elements is then 1097μ. The total length of the chromosomes in *D. melanogaster* is 1180μ (Bridges[1]), which is not significantly more than in *D. virilis*. The lengths of the dot-like chromosomes in both species are approximately equal.

The tentative identifications of the chromosomes have been made chiefly by three translocations. One translocation involves a reciprocal interchange between the 3rd and 4th linkage groups. This translocation was clear and seems definitely to identify these two chromosomes. Two other translocations involve the 3rd and 5th linkage groups. In one of these instances a part of the 5th chro-

mosome is apparently attached to the 3rd in the region of the spindle fibre, thus obscuring the details. In the other instance there is apparently a reciprocal translocation very near the chromocenter region, making a good figure extremely rare. The 6th chromosome is easily identified by its size. The chromosomes labelled A(1?) and B(2?) are probably the 1st and 2nd respectively. The only evidence for this is as follows: (1) in some preparations of male larvae chromosome A(1?) stains less darkly than the other chromosomes; (2) in the examination of many such preparations I have failed to find a split chromosome, a condition fairly common in the autosomes. If A(1?) is the 1st or sex chromosome, then the remaining unidentified chromosome must be the 2nd. I consider this evidence by no means adequate, but highlv suggestive.

A scheme of mapping the detailed topography of the chromosomes similar to that used by Bridges[1] has been adopted. Such a scheme has the advantage of permitting expansion without altering the major coordinates. Two important differences between this map and Bridges' should be noted: (1) The free or non-chromocenter ends of all chromosomes lie to the left, whereas in the map of *D. melanogaster* the chromocenter ends of the 2R and 3R elements lie to the left. (2) Instead of arbitrarily dividing each chromosome into 20 parts, the number of units has been determined by the approximate proportionate length of the chromosomes. Thus we have 21 units for A(1?), 24 for B(2?), 17 for 3, etc., there being 100 units in the entire group.

Acknowledgments are due Professor Hideo Kikkawa of the Imperial University, Tokyo, to whose kindness I am indebted for the use of certain translocations that have assisted materially in the identification of the chromosomes.

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2. Metz, Charles W. Chromosome Studies on Diptera, II. The Paired Association of Chromosomes in the Diptera, and Its Significance. *Jour. Exp. Zool.* 21: 213-279, 1916.

3. Painter, T. S. Salivary Chromosomes and the Attack on the Gene. *Jour. Hered.* 25: 465-476, 1934.

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The Inherited Traits of Robert E. Lee

When the nascent science of genetics is developed, Robert E. Lee will be cited in the case-books along with those who appear in Galton's Hereditary Genius. For his most conspicuous qualities, it may be repeated, were derived in almost equal determinable proportions from his parents and his grandparents. From his Grandfather Lee, came a sense of system, the power of critical analysis that kept him free of illusion, and, along with these, perhaps, his love of animals. His good looks were an endowment from his maternal grandmother, the "Lowland Beauty" at the sight of whom the grave eyes of George Washington are said to have lighted up. To his Grandfather Carter, Robert E. Lee owed much of the religion in his nature, something of his kindness, his love of family life and his devotion to his kin. "Light-Horse" Harry Lee passed on to his youngest son his fine physique, his aptitude for military affairs, his great intelligence, his daring, his sense of public duty, and the charm of manner that made him so readily a captain. The characteristics of his mother that reappear were her religion, her thrift, her self-control, her social sense, and her patience in adversity. If it seems unscientific, at first glance, to speak with so much assurance of Lee's inherited characteristics, it may be said that the celebrity of his forebears and the diligence of the family genealogists make the facts more apparent than in most cases.—Freeman, Douglas, Life of Robert E. Lee.

AWARD OF MEYER MEDAL TO P. H. DORSETT

Photograph by S. H. Hastings

PRESENTATION OF THE MEYER MEDAL TO P. H. DORSETT

Figure 8

Some of the friends of the recipient who gathered to do him honor. From left to right: Dr. Hassell the Zoologist, an old-time friend of Dorsett's. Then O. F. Cook, Guy N. Collins, C. S. Scofield, P. H. Dorsett, David Fairchild, T. H. Kearney and Walter T. Swingle; all men who have made contributions to American agriculture through their introductions of new foreign plants.

THE Frank N. Meyer Medal has been awarded again by the Council of the American Genetic Association, this time to P. Howard Dorsett, a member of the group of persons who built up the Plant Introduction Service of the Department of Agriculture.

Twelve of these medals in recognition of distinguished services in the field of Plant Introduction had already been awarded; four of them abroad and eight in the United States.*

Because of my close personal association with the recipient of this, the thirteenth Medal, I find it difficult to write dispassionately. Our friendship has gone on for over forty-five years and we have literally grown old together, working side by side, each spurred on by the opinions of the other. While I cannot, therefore, judge of his qualifications without prejudice, his accomplishments give such a wide margin of safety that there can be no question of his deserving this honor.

*For a history of the origin of the Meyer Medal, see "A Foreign Plant Introduction Medal," *Journal of Heredity* 11: 168-174. 1920.

Howard Dorsett is a son of the Great Plains, having been born in Illinois seventy-four years ago. I never knew his father, but his mother was one of those remarkable persons whose interest in the life about her was keen to the very end.

He grew up in a pioneer community, in an environment in which self-discipline was perhaps the most pronounced feature. He acquired those habits of vigilance, alertness and persistence without which no farm in this country could be successfully run, at least so it was believed in the eighties. Early hours and late hours were looked upon so constantly as the price of success that they became a fixed habit of existence. To get up at half past three or four o'clock, milk several cows and deliver the fresh milk before the early rising hour of a small town entailed a discipline of the severest type. It was to this rigorous regime that young Dorsett habituated himself, and he has adhered to it throughout his career as a builder of Plant Introduction Gardens and as an Office Administrator and an Agricultural Explorer in foreign countries.

To the work of Plant Introduction, Dorsett did not bring what the obvious-minded would suppose he should have brought and what he always regretted not having—a profound knowledge of systematic botany. He could not identify at sight a very large collection of trees or shrubs and give them their correct botanical names; his interest in plants was not in their names but in their behavior. If there were differences in the behavior of the species he was handling he observed them and steered his course of treatment for each species according to its peculiarities. He spared no pains to give the plants he had charge of the best possible chance to grow and perform.

It was his skill with a hammer and saw, tools not usually associated by botanists with their profession, that enabled him in the early days to avert many disasters which faced thousands of newly introduced plants upon their arrival from the ends of the earth. These emergencies which are encountered in the first few days or weeks of a plant immigrant's arrival are, alas, too often not fully met by Plant Introducers, and their attempts to acclimatize new species often fail in consequence. Particularly have the discouraging problems of contending with the parasites and fungus diseases which Plant Immigrants are heir to proved overwhelming in all too many cases. But with his skill in carpentry and his understanding of machines of all sorts, Dorsett, with his own hands, constructed whatever was needed whenever delays or lack of funds confronted him and threatened to affect the chance of survival of his charges—and *live plants*, it should be remembered, are essential to success in plant introduction.

In the nineties few of the principles of plant introduction as they are now understood had been worked out anywhere in the world. The opportunities were just such as appealed to Dorsett's pioneering instincts. In the creation of the various Plant Introduction Gardens in South Florida, Georgia and Maryland, in the East, and in California and Washington in the West, Dorsett found room for the exercise of his never-tiring industry and skill. The five Gardens which exist today owe their beginnings largely to him.

In these propagating stations millions of young plant immigrants were nursed until they had grown to a size suitable for trial by experimenters throughout the country. It has been Dorsett's good fortune to be associated in this most intimate and useful way with the first appearance in America of such new crops as the Tung Oil tree, the Date Palms and the Japanese Flowering Cherry trees, the Oriental Bamboos, East Indian Mangos, Japanese and Chinese Persimmons and Jujubes, the Chayotes, Dasheens and Chinese Cabbages, Udo, and numerous other plants.

Early in his career he took up photography, and, with his usual zest, perfected his own technique. Today his collection of field and studio photographs constitutes an invaluable record

of the growth of the Plant Introduction Gardens of America. He developed to its logical conclusion a system of illustrated travel reports, the bound volumes of which now cover many shelves in his library and furnish a pictorial account not only of his operations in the building of the various Gardens, but of his travels to and fro in America and later of his collecting trips in Brazil, China and Japan, the Dutch East Indies, Ceylon, Panama, the West Indies and the north coast of South America.

Dorsett's first foreign expedition was to Brazil in 1914, where he went with A. D. Shamel and Wilson Popenoe. The results of their work in Bahia and on the Rio San Francisco are not only recorded in detail in the volumes of Plant Inventories and the photographic archives of the Division, but South Florida is today enriched with such new and useful plants as the Grumichama, *Eugenia Dombeyi*, the Pitomba, *Eugenia Luschnathiana*, the Jaboticaba, *Myrciaria cauliflora*, the forage grass Capim Gordura, *Melinis minutiflora* and other species. These are already beginning to attract the attention of the pioneer gardeners and farmers of the region.

In 1921 Dorsett and I went to Panama together, taking with us among other plants, some little mangosteen trees for the Summit Garden near Ancon. These now form the nucleus of a mangosteen orchard, and are beginning to bear in that garden their delicious fruits each year.

Dorsett's and my own interest in the Soy Bean as a crop for America began in the earliest days of our association in the work of Plant Introduction and his experience with it in our Gardens and as an emergency crop during the World War fixed its importance in his mind. On his first trip to the plains of Manchuria, where soy beans form the staple grain crop, he was stimulated to collect all the varieties he could get his hands on, knowing that from them would come, either directly or through hybridization and selection, the future soy bean varieties of America. He sent in over two thousand strains and varieties during that expedition, and a few years later, on a second trip, when he was accompanied by W. J. Morse, the soy bean expert of the Department, even more were collected. This is not the place for a detailed account of Dorsett's contribution to the great soy bean industry of America; it should appear in the book which I assume Mr. Morse is writing.

On this second long and arduous expedition to Manchuria, Dorsett came down with double pneumonia and would probably have died had it not been for the care given him by Ruth Dorsett, his daughter-in-law, who had accompanied him.

Of Dorsett's work in Ceylon, Sumatra and Java in 1925-26 I have personal knowledge, for, as I have described in *Exploring for Plants*, he and his son, Jim, left their winter camp in Manchuria and joined Mrs. Fairchild, our son and me in Kandy, Ceylon. There we spent several months together in those wonderful tropical islands, collecting handsome shade trees, tall palms, bamboos, flowering vines and fruit trees, a number of which may be seen today growing in South Florida. They were unforgettable days—those in the jungles of Sumatra and Java.

It is perhaps instinctive to give the credit for the ultimate success of an invention or discovery to one person only; the one whose intellect we believe first conceived it, or whose initiative first brought about its use, yet in the work of introducing a new foreign plant into culture, this instinct sometimes leads us astray. Often it is not to the one who first brings in a new species and grows it in a collection somewhere that the honors should be given, but to the one through whose persistent efforts it finally comes into more or less extensive use in its new home country; at least to be fair, the honors should be divided. It is, therefore, for Dorsett's work in making possible the production of large numbers of newly imported plant immigrants and their distribution to experimentors quite as much as for the thou-

sands of seeds and plants he collected with his own hands in foreign countries that the Council decided to award him the Meyer Medal.

The presentation ceremonies took place on June 2 on the lawn of the Plant Introduction Garden at Bell, Maryland, with whose beginnings Dorsett had a great deal to do, putting into the building of it the tireless energy which his friends have come to associate with everything he does.

The occasion brought together many of the "Old Guard" of Plant Introduction, both clerical and scientific. These outstanding men of science are all old friends of Dorsett and delighted to see him honored. It was an occasion that brought up many interesting memories, reminding us that in persons still living have resided forces which are even now making profound changes in American agriculture.

DAVID FAIRCHILD

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NEW EDITION OF BAUR-FISHER-LENZ

THE fourth edition of this classical work* presents an up-to-date summary of the facts and principles of the genetics of human beings. Much new material appears, both in the form of illustrations and text. The junior authors pay a deserved tribute to Baur, whose death occurred since the publication of the previous edition. An excellent picture of Baur serves as a frontispiece.

Comparing this edition with the third, one finds that Baur's section on general genetics is least modified, as would be expected. New material in this section consists of a discussion of lethal factors and the inclusion of the latest chromosome maps of Drosophila. Giant chromosomes are not mentioned.

Fischer's section on racial differences in mankind is extensively rearranged and augmented. New material includes discussions of finger and palm prints, features, blood groups, the M-N reaction, and the diagnosis of identity in twins. The plates of racial types are rearranged and increased in number.

The section by Lenz on morbific factors has been extensively rewritten. New pedigree charts have been added, and the discussions of various characters have been brought up to date on the basis of recent literature. In this connection much fuller use has been made of American literature than in the earlier editions. The newly-discovered taste deficiencies are briefly mentioned.

Lenz' section on methods of analyzing human inheritance has been augmented by a brief outline of probability, and by a considerable discussion of the twin method of research. Nothing is said, however, of the recent developments of the gene-frequency method of analysis.

As in the previous edition, the volume closes with a discussion of intellectual capacities and their inheritance, with especial reference to the racial question. The Jews and their contributions to science and culture are discussed with the same dispassionate fairness as before, and seem happily not to have suffered at the hands of the authors in spite of recent political activities along this line. All in all, the book upholds the standard set by previous editions, and is still a very necessary part of the equipment of the student of human inheritance.

Ohio State University L. H. SNYDER

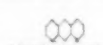
*Menschliche Erblehre, by ERWIN BAUR, EUGEN FISCHER, and FRITZ LENZ. Fourth edition, rewritten. Pp. VIII + 796. München, J. F. Lehmanns Verlag. 1936.

THE THREE-(BENZINE) RING BIOCHEMICAL CIRCUS

Cancer-producing Agents, Sex Hormones and Vitamins Linked by the Newer Organic Chemistry

STRANGE as it may appear, this book,* which details the developments in what were originally widely separated fields in the organic chemistry of highly complex products of plant and animal organisms, is replete with dramatic incidents. The astounding analytic and synthetic work of the organic chemists of many countries (and American chemists have contributed their fair share) has demonstrated the common chemical relationships between many alkaloids, resin acids, cancer-producing hydrocarbons, sterols and bile acids, sex hormones, heart poisons and saponins—besides locating and identifying, in most cases, the specific groups and side chains and "bridges" responsible for the great divergences in properties. Incidentally, because of the small quantities of material available for the investigation of cholic acid, Pregl was led to develop his classical methods of microanalysis, for which he received the Nobel prize. Windaus and Wieland, among the many workers in this field, have also received the Nobel prize.

The prototype of all these very different substances is phenanthrene, first isolated in 1872 from coal tar, where it occurs with its isomer, anthracene. While in anthracene the three benzene rings are in straight line formation, in phenanthrene one of the rings is offset:



ANTHRACENE

PHENANTHRENE

As we shall see, this makes a tremendous difference in the three-ring circus which develops when the various groups and side chains make their bows in the three benzene rings of the phenanthrene nucleus, with "bridges" or extra rings clowning alongside. And the "show" is of vital interest to the biologist, for it may indicate the basis of certain taxonomic and phylogenetic relationships between various plants and animal groups—possibly even between plants and animals. The physiological effects which are produced by differences in arrangement of molecular groups are, of course, of fundamental interest to the geneticists, now that it is becoming almost a commonplace that the gene is some sort of chemical laboratory. The importance of specific chemical substances as possible "modifiers" of bio-catalysts (genes and enzymes) has been pointed out in the April number of this JOURNAL, pp. 139-150. Such molecules thus become *directors of the directors* of the chemical processes of life.

Even to the organic chemist who has not been keeping track of the great advances in this field, the technical portions of this book will hardly class as light mid-summer reading. Thus morphine, one of the phenanthrene alkaloids, is described as "a hexahydrophenanthrene derivative having a phenolic hydroxyl group (C_3), a secondary alcoholic group (C_6), an oxide bridge between positions 4 and 5, and an ethanamine chain, $—CH_2CH_2N(CH_3)—$, inserted between positions 9 and 13 and constituting part of a six-membered heterocyclic ring." All this is indicated in the following structural diagram (from page 25):

MORPHINE

By methylation the OH group in position 3 becomes CH_3O—and the habit-forming morphine has become

*FIESER, L. F. The Chemistry of Natural Products Related to Phenanthrene. Pp. XII 358. New York. Reinhold Publishing Co., 1936.

the much more useful and less dangerous codeine. On dehydration with acids, accompanied by a molecular rearrangement, morphine becomes apomorphine and acquires properties which permit its use as a hypodermic emetic, though the original morphine is a sedative (e.g., paregoric for the "green-apple quick-step"). Incidentally, this transformation opened the door to the structure of the apomorphine alkaloids (including papaverine). In all, about 23 alkaloids have been isolated from opium, an indication of the diverse chemical processes which go on easily, silently, and continuously in the biochemical plant. But in the laboratory compounds are being made which may prove superior to morphine and which are as yet quite unknown in nature (p. 46).

The structures of the resin acids and of oleoresins have been developed only within the last few years, largely by the work of Ruzicka, Haworth and their collaborators. Abietic acid, from resin, has a formula which is resolvable into four isoprene units, and isoprene is a raw material for making synthetic rubber. By combining a naphthalene derivative with succinic anhydride, Haworth added the beginning of a third ring which was closed by treatment with 85 per cent sulphuric acid, giving phenanthrene derivatives. Other methods of cyclizations were developed by Bardham and Sengupta (India) and by Perlman, Davidson and Bogert (U.S.A.)

Cancer and Sex

The next chapter deals with cancer-producing hydrocarbons. Since certain tars were known to contain carcinogenetic substance, Kennaway and his associates at the Free Cancer Hospital (London) tested all known substances which were supposed to be possibly present, without result. And it took nearly a year per mouse-test until the discovery by Mayneord and Hieger that the fluorescence spectroscope gave characteristic results with active tars and oils, thus speeding up the search. Finally (1933) Cook, Hewitt and Hieger isolated from active coal-tar a hitherto unknown hydrocarbon with five benzene rings, 1, 2-benzpyrene, which was present to the extent of about 0.003 per cent. Synthesized material was just as potent as that found in the tar—epithelomias follow application to the skin, but connective-tissue cancers (sarcoma) follow subcutaneous injection; and the induced tumors strongly resemble those which arise spontaneously. Then a still more potent carcinogenetic substance, methylcholanthrene, became the focus of investigations, many of them by Prof. Fieser and his collaborators, who obtained it from cholic acid which is found in bile. "While proof is entirely lacking, it appears possible that many forms of cancer may originate in the metabolic production of methylcholanthrene or related substances from the bile acids, or perhaps from the sterols or sex hormones, of the body." Since the growth of a transplanted tumor is more rapid than one originally produced by this hydrocarbon, some permanent change in the cell catalysts (genes or enzymes) appears to be involved. Some pure, inbred strains of mice are highly susceptible to implantation of tumor tissue, and the "takes" are malignant. Prof. Fieser states that methylcholanthrene is the most potent carcinogenetic substance known.

Chapter IV takes up the Sterols and Bile Acids. Most helpful in this field was the discovery by Windaus (1909) that cholesterol forms a stable but sparingly soluble molecular compound with digitonin, a glycosidic saponin from digitalis, which is also a phenanthrene derivative (see p. 118 *et seq.*). Sterols from plants (phytosterols), e.g., ergosterol, are not taken up by the animal organism, even if injected intravenously: but when irradiated, ergosterol is easily absorbed. "Absorbability is highly dependent upon chemical constitution for, in contrast to cholesterol, such closely related substances as dihydrocholesterol, coprosterol, and allocholesterol are not appreciably absorbed through the intestinal wall but pass directly into the feces." Bergmann (1934) discovered that oysters and other bivalves contain,

in place of cholesterol, a C_{29}-sterol, ostreasterol; ". . . the close relationship of this zoosterol to the common phytosterols is shown by the fact that the substance is an isomer of stigmasterol and yields sitostanol on hydrogenation." Bergmann points out that though certain molluscs are unable to synthesize cholesterol, they utilize the phytosterols of their food (mainly algae and diatoms); and Heilbron (1934) isolated from algae fucosterol, an isomer of ostreasterol, which can be converted into stigmastanol. Bile salts act as protective colloids, keeping water-insoluble substances in solution or dispersion, and enabling lipoids to become absorbed on the intestinal musoca. Choleic acid, instead of a true bile acid, turns out to be "a coordinative compound containing one molecule of the fatty acid and no less than eight molecules of desoxycholic acid . . . the stearic acid is so firmly bound that it can be split off only with difficulty, as by transforming the bile acid into products of dehydration of oxidation." There is a variety of "choleic acids," which, from their behavior (p. 131) might be regarded as adsorption compounds.

Barn-Drama Among the Radicles

The sterols and their congeners arise from having a five-carbon ring added like a "lean-to" or a "barn" to the phe-

THE "STEROL BARN"

nanthrene nucleus. Differences in added groups and side-chains, and their points of fixation, as well as stereoisomerism, make possible an enormous number of compounds, each with its own characteristic behavior. Thus cholic acid contains no less than eleven asymmetric carbon atoms. If another benzene ring forms with a methyl group in proper position, we have the deadly methylcholanthrene.

METHYLCHOLANTHRENE

Chapter V deals with Sex Hormones, in which the phenanthrene nucleus with the "barn" attachment has certain suitable atoms or groups affixed in certain locations; and it is interesting to note the relatively slight chemical differences in the diagrams for the female hormones (oestrone and progesterone) and the male (androsterone and testosterone) (p. 187). In pregnancy, prolan appears in the urine, and is used as the basis of the Ascheim-Zondek and Friedman tests for this condition (p. 190). In 1932, when only about 25 milligrams of androsterone had been obtained in pure condition, Butenandt suggested what has since been proven to be the correct formula.

Chapter VI deals with the heart poisons (cardiac glycosides and toad poisons)—digitalin, strophanthin, bufotalin, etc., long known as arrow-poisons, folk-medicines, etc. The toad figures in the Chinese pharmacopeia, and its skin yields, besides a heart poison, something akin in action to adrenalin. In these compounds the chemical complications thicken a bit. "There are definite indications that the cardiac effect is intimately associated with the unsaturated lactone ring."

Chapter VII discusses saponins, e.g., from soap bark, liquorice, sarsaparilla, including some remarkable properties of digitonin.

To your reviewer, it would seem that this book is of especial interest to biologists in showing how powerful and diverse biological effects may follow relatively simple chemical changes which occur when these phenanthrene compounds run the gauntlet of the specific catalysts and conditions found in different plants and animals. It would appear possible to utilize chemical facts of this nature as an aid in resolving moot questions in taxonomy and phylogeny.

The book is well and clearly printed, and the indexes are excellent. Perhaps in the next edition Prof. Fieser will see fit to add a glossary giving in epitome, with literature references, information as to such things as "Adam's platinum oxide catalyst," "the technique of Tschopp," "the Blanc rule," etc. Many of these are not quite well known in the very wide circle that ought to read his book.

JEROME ALEXANDER

ENVIRONMENT IN A EUGENICS PROGRAM

Dr. Julian Huxley See Joint "Nature-Nurture" Attack Necessary

THE *Program of Eugenics* published by the American Eugenics Society late in 1935* marked a definite departure in eugenic thought in placing strong emphasis on the need to consider environmental factors as basic elements in a well grounded eugenics program. It is therefore significant that a very similar view is put forward by the distinguished British biologist Julian Huxley in the Galton Lecture of the British Eugenics Society on February 17, 1936. This lecture is published in full in the *Eugenics Review* for April, 1936. It deals broadly with the problem of eugenics and society, considering at length the place of eugenics as a science and its relations to other social sciences, the need for study of environment, the race concept, and genetic differences between races and classes, eugenics and religion, etc.

The question of environment in a eugenic program is introduced by a discussion of artificial selection in relation to different environments, with emphasis on the fact "that selection is theoretically meaningless and practically without value except in relation to a particular environment." Examples from cattle breeding experience in Africa, where the "superior" dairy breeds are unable to compete with the native cattle—"stubby little beasts, no bigger than ponies, yielding not more than two gallons of milk a day, and growing so slowly that they do not breed until four or five years old." When the environment was modified by the use of mineral fertilizer, salt licks, watering facilities, etc., there was a different story to tell. This is also true in Stapledon's studies of improving moorland grazing areas. Here the relatively sparse pasture could only be altered by a genetic transformation (introduction of strains of forage grasses adapted to the high altitudes) and environmental transformation (destruction of existing flora, fertilizers, etc.) Dr. Huxley then takes up the question of eugenics in relation to human environment:

> Precisely the same considerations apply to the improvement of man. Our schemes for improving the genetic qualities of the nation or the species are meaningless except in relation to some particular environment, present or future. Our eugenic ideals will be different according as we relate them to a slave order or a feudal order of things, a primitive industrial or a leisure order, a this-worldly or an other-worldly order, a capitalist or a socialist order, a militarist or a peaceful internationalist order. Even if we imagine we are working to absolute genetic standards, we are in reality thinking of them, albeit unconsciously, in relation to some ideal environment of the future, or to the needs and realities of the present social environment, or, very frequently, to our biased and *a priori* views about this present environment and how in our opinion it ought to be changed. If we were really treating of absolute genetic standards, we should have deserted reality for a metaphysical vacuum, and our reasoning and deductions would have even less value than a discussion of, say, eugenics in heaven. (Even in this latter case, be it noted, the discussion would inevitably be related to the environment which we supposed was awaiting us in the next world!)
>
> Now all such unconscious thinking is inevitably irrational or at best non-rational: if it had been submitted to the light of reason, it would no longer be unconscious. So that a prime task before eugenists is the reasoned formulation of their views on the environment to which their schemes of genetic betterment are to be related.
>
> There are, it seems to me, three possible courses to be pursued. Either we may accept as given our present type of social environment, and adjust our eugenic program to it. In practice we shall of course be forced to take a dynamic instead of a purely static point of view, and consider the trends of change within that environment, while assuming that the social system will not be fundamentally altered. Or, going to the opposite extreme, we may assume an ideal social en-

*See *Journal of Heredity*, May, 1936, pp. 195-201.

vironment—more scientifically, one which is the optimum we can imagine—and plan our eugenic measures in relation to that, piously hoping that in the long run social change will adjust itself to our ideal or to whatever measure of genetic change we may have brought about. Or finally we may envisage, as in Stapledon's grassland work, a joint attack upon environment and germplasm. Assuming that we have some measure of control over the social environment, we shall adjust our genetic program to that program of environmental change which represents, both in direction and tempo, a happy mean between the ideal and the immediately practical, between what we should like and what we are likely to get.

Let us look at these three alternatives and their implications. First, however, it should be pointed out that they are not wholly alternative to each other. Even if we take the environment for granted, we must face the fact of social change and attempt to meet it eugenically; and in so doing we shall find it difficult to avoid giving some play to our wishes, fears, and hopes. Even if we assume an optimum environment, our ideal must be based on our conscious or unconscious estimate of what developments are inherently possible to the present system. We shall, in effect, be attempting to forecast social improvement, and we shall prove, we can be sure, as widely out in our forecasts as if we were attempting to prophesy the future of scientific discovery. And the third method, of necessity, must take into account both the hard fact of the present and the ideal of wishes and hopes for the future.

* * * *

Dr. Huxley discusses the eugenic difficulties of the capitalist-nationalist system and finds them formidable. Such a system seems inevitably to demand "a cheap supply of unskilled and semi-skilled workers," and "man-power in case of war," which he sees as all but fatal obstacles to an harmonious integration of genetic and environmental factors. The question of the relative merits of the two currently most popular alternatives,—the fascist and the communist—is not discussed here but is touched on below. It is clear that he does not consider a solution can be reached by the mere adoption—on faith—of any existing socio-political formula. He continues:

> It will, however, by now have become clear that neither of these approaches is so satisfactory as the third. Indeed, neither is methodologically sound. If the aim of eugenics be to control the evolution of the human species and guide it in a desirable direction, and if the genetic selection should always be practised in relation to an appropriate environment, then it is an unscientific and wasteful procedure not to attempt to control environment at the same time as genetic quality. Science is simultaneously both theory and practice, both knowledge and control. For the applied science of eugenics to neglect the environment is a source both of confusion and of practical weakness. I would go farther: I would say that we cannot succeed in achieving anything in the nature of adequate positive eugenics unless we attempt the control of the social environment simultaneously with the control of the human germ-plasm, any more than Stapledon could have improved his rough mountain grazings save by a similar double attack.
>
> Let us then look more in detail into this third or dual method of approach. It has two facets, theoretical and practical. On the theoretical side, we shall only progress in our attempt to disentangle the effects of nature from those of nurture in so far as we follow the footsteps of the geneticist and equalize environment. We shall never be able to do this in the same radical way as the pure scientist, by testing out a whole range of controlled and equalized environments on selected stocks. We must therefore concentrate on producing a single equalized environment; and this clearly should be one as favourable as possible to the expression of the genetic qualities that we think desirable. Equally clearly, this should include the following items. A marked raising of the standard of diet for the great majority of the population, until all should be provided both with adequate calories and adequate accessory factors: provision of facilities for healthy exercise and recreation; and upward equalization of educational opportunity. The further we move in this direction, the more readily shall we be able to distinguish inherent physical and mental defects from environmental stunting and frustration; the higher we raise the average, the more certain shall we be that physical or mental performance above the average is dependent upon genetic endowment and therefore provides the raw material for positive eugenics. Not only this, but we know from various sources that raising the standard of life among the poorest classes almost invariably results in a lowering of their fertility. In so far, therefore, as differential class-fertility exists, raising the environmental level will reduce any dysgenic effects which it may now have.
>
> Returning, however, to the more important aspect of the eugenic knowledge to be gained by levelling up the social environment, I anticipate that at the bottom, the social problem group, though shrinking in size, will be left, clearly marked out by its inadequate

performance in the new and favourable conditions, as a well-defined target for measures of negative eugenics such as segregation and sterilization; and that minor targets of the same nature will emerge out of the present fog, in the shape of nests of defective germ-plasm inspissated by assortative mating and inbreeding, such as have been imaginatively glimpsed by Lidbetter and others. I further anticipate that the professional classes will reveal themselves as a reservoir of superior germ-plasm, of high average level notably in regard to intelligence, and therefore will serve as a foundation-stone for experiments in positive eugenics. And I anticipate that society will tap large resources of high ability that are at present unutilized, thus facilitating the social promotion of at least certain fitter elements; and without social promotion we cannot proceed to reproductive encouragement. This is the scientific ideal at which we should aim. Like many other ideals, we shall not achieve it; but any approach to it will help us towards a more certain knowledge.

Science, however, is control as well as knowledge; and new practice may advance theory as much as new theory lay the basis for practice. This is especially true for the social sciences, where, as we have seen, rigorously controlled experiment, on the pattern of pure physics or physiology, is impossible, and problems must frequently be solved *ambulando*. We make a partial experiment which is simultaneously pure and applied science. The experiment is both an attempt to gain knowledge and an effort to realize a wish, a desired control. It is planned, like more crucial experiments in the natural sciences, to verify deductions from known facts. In so far as the desired end is attained, the deductions are verified and knowledge is increased: and even if the control is not attained, knowledge is increased, though not to the same extent.

This more empirical mode of attack must also be used in eugenics. We must attempt to control the change of social environment and at the same time to control the change of human germ-plasm, along lines which appear likely to yield tangible and desirable results. It is the results which interest us. Admirable germ-plasm unable to realize itself owing to unfavorable conditions does not interest us: nor do the most alluring social conditions, if they permit or encourage the deterioration of the germ-plasm. Thus the two attacks must be planned in relation to each other, and also in relation to practicability.

* * * *

The Eugenic Approach to Control of the Social Environment:

What sort of practical changes, then, should we as eugenists try to encourage in the social and economic system? In the first place—what we have already noted as desirable on theoretical grounds—the equalizing of environment in an upward direction. For this, by permitting of more definite knowledge as to the genetic constitution of different classes and types, will at once give us more certainty in any eugenic selection, negative or positive, upon which we may embark; and secondly, we must aim at the abandonment of the idea of national sovereign states, and the subordination of national disputes to international organization and supernational power.

But we need something more radical than this—we must try to find a pattern of economic and communal life which will not be inherently dysgenic; and we must also try to find a pattern of family and reproductive life which will permit of more rapid and constructive eugenics.

On the first point, it seems clear that the individualist scramble for social and financial promotion should be dethroned from its present position as main incentive in life, and that we must try to raise the power of group incentives. Group incentives are powerful in tribal existence, and have been powerful in many historical civilizations, such as the old Japanese. What interests us chiefly, however, is to find that they have been to a large extent effective in replacing individualist money incentives, or at least diminishing their relative social importance, in several modern States, notably Germany and the U. S. S. R.

* * * *

These passages have been chosen for comparison with the recently published American view, and for that reason they hardly do justice to the very broad and comprehensive nature of the whole lecture. In conclusion Dr. Hurley stresses the thought that today, thanks to the last fifteen years' work in pure science, we can be sure of the alarming *fact* (which before that time was only theory) that a definite "tendency to the degradation of the germ plasm" exists in civilized man and is increasingly manifesting itself:

It is to my mind not only permissible but highly desirable to look far ahead. Otherwise we are in danger of mistaking for our eugenic ideal a mere glorification of our prejudices and our subjective wish-fulfillments. It is not eugenics but left-wing politics if we merely talk of favoring the survival and reproduction of the proletariat at the expense of the bourgeoisie. It is not eugenics but right-wing politics if we merely talk of favoring the breeding of the upper classes of our present social system at the expense of the lower. It is not eugenics but nationalist and imperialist politics if we speak in such terms as subject races or miscegenation. Our conclusions in any particular case *may* be on balance

eugenically correct (though the correlation between broad social or ethnic divisions and genetic values can never be high), yet they will not be based primarily upon eugenic considerations, but upon social or national bias. The public-school ideal, or that of the working-class movement, or that of colonial imperialism, may be good ideals; but they are not eugenic ideals.

The Danger of Man's Genetic Degeneration: Conclusion

Before concluding, I should like to draw attention to one eugenically important consequence of recent progress in pure genetics. In all organisms so far investigated, deleterious mutations far outnumber useful ones. There is an inherent tendency for the hereditary constitution to degrade itself. That man shares this tendency we can be ure, not only from analogy but on the all-too-obvious evidence provided by the high incidence in "civilized" populations of defects, both mental and physical, of genetic origin.

In wild animals and plants, this tendency is either reversed or at least held in check by the operation of natural selection, which here again proves itself to be, in R. A. Fisher's words, a mechanism capable of generating high degrees of improbability. In domestic animals and plants, the same result is achieved by our artificial selection. But, in civilized human communities of our present type, the elimination of defect by natural selection is largely (though of course by no means wholly) rendered inoperative by medicine, charity, and the social services; while, as we have seen, there is no selection encouraging favorable variations. The net result is that many deleterious mutations can and do survive, and the tendency to degradation of the germ-plasm can manifest itself.

Today, thanks to the last fifteen years' work in pure science, we can be sure of this alarming fact, whereas previously it was only a vague surmise.* Humanity will gradually destroy itself from within, will decay in its very core and essence, if this slow but relentless process is not checked. Here again, dealing with defectives in the present system can be at best a palliative. We must be able to pick out the genetically inferior stocks with more certainty, and we must set in motion counter-forces making for faster reproduction of superior stocks, if we are to reverse or even arrest the trend. And neither of these, as we have seen, is possible without an alteration of social system.

Whether or not I have been asking you to accompany me too far into the visionary future, I will end this lecture with a very concrete suggestion for the present, backed by a warning from the immediate past.

Twenty-five years ago, when I had just taken my degree, the field of heredity was still a battle-field. The Mendelians and the Biometricians were disputing for its possession, and in the heat of the struggle little mercy was shown by either side to the other. In the last dozen years or so, however, the apparent conflict of principles has been shown not to exist, and now, thanks to the work of such men as R. A. Fisher and J. B. S. Haldane, we realize that the two methods of approach are complementary, and that certain important problems can only be solved by their simultaneous employment.

The present position of Eugenists appears to me to be closely parallel with the position of the Mendelians a quarter of a century ago. They find themselves in apparent conflict with the environmentalists and the protagonists of social reform. Speaking broadly, the field of human improvement is a battlefield between Eugenists and Sociologists, and the battle is often as violent as that between the Mendelians and Biometricians—or between Swift's Big-endians and Little-endians. In my opinion, it is also as unreal and useless. We eugenists must no longer think of the social environment only in its possible dysgenic or non-eugenic effects, but must study it as an indispensable ally. Changes in social environment are needed both for the adequate expression of eugenic progress, and as a means for its realization.

The next step for eugenics is, as I urged at the beginning of this address, a methodological one. We eugenists must familiarize ourselves with the outlook and the concepts of sociology, with the technique and practice of social reform; for they are an indispensable part of the machinery we need to realize our aims.

*MULLER, H. J., 1935. *Out of the Night*, Vanguard Press, New York. (See *Journal of Heredity*, 27: 132-135. 1936.)

✦

APPLICATIONS OF BIOLOGY TO HUMAN AFFAIRS

TO THE EDITOR:

I have read with much interest Dr. Muller's comment on my review of Graubard's book.

The main difference between Muller's views and mine seems to be that he believes that the average citizen is or can be educated to a point where he can take a *constructive* and important part in planning the application of biology to his own problems. He feels that under these conditions science and non-partisanship will

govern human affairs. He feels that a proletarian state will be fair and impersonal. My attitude is that the application of biological principles to the problems of the average man should be in the hands of specially trained individuals whose background is such as to give them a directive point of view in the practical working out of this problem. I believe that the average citizen of the United States (or, for that matter, of the U. S. S. R.) is not now and cannot in the reasonably near future be well enough educated in a *scientific point of view* to be as impersonal and far-seeing in self evaluation as can a body of trained scientists.

All the practical evidence would seem to favor the point of view which I hold. Let us, for example, take the application of justice. According to Muller's theory if I understand it aright, there should be no need of a machinery for the enforcement of justice because the individual should be able and willing to apply the principles of legal self control to all his actions. Practically, however, it has been found that this is not the case. From the lowest grades of courts up to the Supreme Court the only guarantee of impersonal administration of legal principles has been the assistance of a trained body of men who are pledged to the ethical performance of their duties. It is true that their record is not perfect, but it compares very favorably with the performance of trial *en masse*, which in the end has generally meant trial by mob. It is equally true that in large and complicated civilizations authority must be centralized, and the question remains: who is to exercise this authority, the trained man who attempts to carry out a code, or the untrained man, who tends much more frequently to become a despot guided by his own emotions and by the mass whim of the moment?

In organic evolution it appears that organisms discovered (if I may be pardoned the figure) that the delegation of equal authority to every cell of the body did not produce as adaptable and efficient an individual as when a central nervous system with directive powers was developed. In a similar way the higher organism controls by *centralized* agents the rate of reproduction of its various constituent parts. Cancer and other abnormalities show that the potentiality for uncontrolled reproduction continues to exist. If the cells of the body are left to their own devices, their ability as wise critics of their own importance is practically nil and the result is suicide for the "individualist" cells through death of the entire organism. Without straining our analogy too far, we may use it as a "background of reference" in considering this important social question of the "dictatorship of the proletariat" (which inevitably means mass coercion by the untrained) *vs* the opposed ideal of the directorship of the specialist.

I do not feel that the dangers from the system which I advocate are as great as those inherent in the Marxian social set-up which Muller favors. I base this statement on the following: It is easier to eliminate or to change centralized control than it is to modify any system of social control (no matter how bad it may be) in which every individual participates. We are having a small example of that in the present economic and political situation in this country. The fact that millions of people are receiving economic independence through direct governmental contribution has created a situation which quite possibly has already gotten out of control. Compared with the ease with which the country discredited the centralized Republican form of federal influences, the difficulties in circumscribing and controlling the so-called "Democratic administration" of the same problems will be tremendous. If we may return to our biological analogy, it is often possible to redirect the functional activities of an organism, so that serious lesions of the nervous system, of the digestive, or muscular systems, are not necessarily fatal, but the only cure known for cancer is the prompt destruction of all cells which have declared a holiday from the "burdens of specialization."

The claims of the Marxists of a monopoly of scientific truth with regard to man seems to the writer to smack more of the pulpit or the soap-box than the laboratory. The danger in the Marxian theory is the production of a social cancer outside of all orderly control. The weakness in my theory is the danger that the centralized control may be partisan. Of the two I much prefer the continued experimentation with modifications of the whole method, rather than playing our whole hand of cards and finding out afterwards that the other fellow has all our money.

C. C. Little

INTRODUCTION TO EUGENICS*

THIS book by an Italian obstetrician deals only with the background of eugenics, heredity, and variation. It takes a firm stand for the inheritance of acquired characters. Its simple and conversational style should make it useful to a wide circle of readers.

Paul Popenoe

*Cristalli, Giuseppe. *Introducione allo Studio dell' Eugenica.* Pages 218, price, L. 15. Stabilimento Ind——le Editoriali Meridionali, 1934.

SEXUAL DIMORPHISM IN SINGLE COMB RHODE ISLAND RED DOWN COLOR

T. C. Byerly and J. P. Quinn

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POULTRYMEN have long sought means to distinguish male chicks from females at hatching time. The Japanese workers, Masui and Hashimoto[2] reported in 1933 the practicability of distinguishing sex by means of the rudimentary copulatory organ and this method has spread very rapidly in the United States, especially among producers of Single Comb White Leghorns in the West Coast States. Sex-linked characters are also used to a limited extent to enable the producers to distinguish males from females.[1] This method has the disadvantage of necessitating the use of a cross between two breeds or strains of chickens. Single Comb Rhode Island Red males mated to Barred Plymouth Rock females give black females and barred males, distinguishable by means of down color at hatching time. Rapid feathering males mated to slow feathering females yield males with very small primary wing feathers and females with much larger primary wing feathers at hatching time. The Red × Rock cross is fairly popular among broiler producers. The slow feathering × rapid feathering cross was described by Warren.[7] It is used to a limited extent. Punnett and Pease[3] have developed a breed of chickens, the Cambar, in which the males and females may be segregated at hatching time by down color.

There still exists a need for the discovery or development of external characters in the existing popular breeds of chickens by means of which sex can be distinguished at hatching time. The Japanese method requires a considerable degree of skill and training, while crossbreeding requires the maintenance of two pure breeds for crossing.

During the fall of 1935, the senior author of the present paper found that many Single Comb Rhode Island Red chicks hatched from eggs produced by the flocks at the National Agricultural Research Center at Beltsville, Md., showed sexual dimorphism in down color. Most of the females had some black down, varying from a few black ticked down feathers at the base of the head to complete black striping on both head and body, while most of the males showed complete absence of black down.

It is rather remarkable that the relationship between black in the down and sex among Single Comb Rhode Island Red chicks has not been studied before. Warren[6] reported that down color is inherited, and noted that 29 of 34, or 85.3 per cent, of the striped chicks examined were females. He made no statement concerning chicks with a black spot on the head. No other work has come to the authors' attention.

The study was therefore undertaken on the distribution of black down, especially on the back of the head, among Single Comb Rhode Island Red chicks and its relation to sex.

Materials and Observations

Observations on down color of 1,102 chicks and dead-in-shell embryos of 18 or more days' incubation, from the National Agricultural Research Center flocks, are presented in Table I. The sex of each was determined by dissection. These flocks are production-bred from standardbred stock with one

VARIATION OF SPOTTING OF RHODE ISLAND RED CHICKS

Figure 9

A, unspotted Rhode Island Red chicks; *B*, chicks with a spot of pigment on the head only; *C*, chicks with a stripe on the head; and *D*, chicks with the stripe extending down the back. Studies of eleven hundred Rhode Island Red chicks show that the chicks without spots or stripes are predominatley males and the chicks showing pigment in these regions are nearly all females. In this group, separation on the basis of spotting or lack of spotting would have selected the sexes with an accuracy of about 80%. The value to the poultryman of a characteristic by which the sexes can be separated at time of hatching is obvious.

subsequent importation of Amherst and one of Parmenter stock. When observations were begun, chicks bearing black pigment on the back of the head were all classified as "spot"; later, those bearing striping were classified separately. Thus, the "spot" class includes some striped chicks.

The data in Table I show that 84.9 per cent of the spotted or striped chicks were females while 77.8 per cent of the non-spotted were males. Expressed in another way, the sex of 895 of the 1,102 individuals examined, or 81.2 per cent, could be distinguished by the presence or absence of black down. The percentage of females among striped chicks, 93.6, is higher than that for the total number of spotted and striped, 84.9 per cent. It was often observed that those spotted or striped chicks which were males bore relatively little black pigment. Of the chicks examined, 524 or 47.5 per cent were spotted or striped.

It seemed desirable to check the presence and distribution of black color in the down of chicks from another standardbred flock of Rhode Island Reds to determine whether striping and spotting are widely distributed among the chicks of this breed. The breeding flock chosen was of excellent color and consisted of 132 females and 12 males. All the females and 11 of the males had solid red undercolor in their plumage, the remaining male had a trace of smut or dark color in the underpart of the plumage between the shoulders. The flock is one of two Single Comb Rhode Island Red flocks in the Maryland Approved and Passed class as of January, 1936.* The stock was said to be derived from the Tompkins strain. It was impracticable to check the sex of the chicks hatched but the data show that these standard bred chicks showed about the same distribution of black pigment as found at the National Agricultural Research Center. Six hundred and sixty-three chicks were examined; of these 127 were spotted and 152 striped, making a total of 279, or 42.1 per cent, either spotted or striped.

Discussion

It is known from Warren's work[6] that some variations in Single Comb Rhode Island Red down color are inherited. The inheritance of spotting and striping in the down among Single Comb Rhode Island Reds is being studied at the National Agricultural Research Center. The data presented cannot be directly due to the effects of a single, dominant, sex-linked inhibitor of spotting such as reported by Rittershaus[5]. Such a gene was reported to be present in Orloffs and Plymouth Rocks, absent in Gold Spangled Hamburgs. The proportions of spotted and non-spotted chicks among the females and males do not accord with such an hypothesis. The data could be accounted for on a basis of two or more genes affecting spotting and striping, at least one of which must be sex-linked, and possibly identical with the *KO-ko* alleles of Rittershaus.[5]

The case may be comparable in part to the Cambar in which the presence of two sex-linked genes for barring in the male is supposed to be responsible for the production of light down color while the single gene for barring in the female permits the appearance of darker down.

The results might be due to sex-limited inheritance with black augmented by the action of the female hormone as is the case in some adult birds (see Quinn and Burrows[4] for discussion and literature) and this possibility is being investigated.

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* Circular 113, University of Maryland Extension Service. The authors wish to express their appreciation to Mr. R. E. Beall of Berwyn, Md., owner of the flock producing the standardbred Rhode Island Red chicks, for permission to examine his chicks.

Summary and Conclusions

Among 1,102 Single Comb Rhode Island Red chicks and embryos of 18 or more days' incubation examined at the National Agricultural Research Center, 524 or 47.5 per cent had some black down on the back of the head. Four hundred and forty-four or 84.9 per cent of the striped or spotted chicks were females while 450 or 77.8 per cent of the non-spotted, non-striped, chicks were males. Thus, sex could be distinguished within these Rhode Island Red chicks by means of spotting or striping among 895 or 81.2 per cent of the chicks and embryos examined.

Two hundred and seventy-nine or 42.1 per cent among 663 chicks from a standardbded flock showed striping or spotting. Presumably, therefore, spotting and striping are widely distributed among Single Comb Rhode Island Reds.

TABLE I. Spotting and striping in the down color of Single Comb Rhode Island Red chicks as related to sex.

	Males	Females	Total	Percent ♀ ♀
Spot	71	328	399	82.2
Stripe	8	117	125	93.6
Sub Total	79	445	524	84.9
Percent	15.1	84.9	100.0	
Non-Spot	450	128	578	22.2
Grand Total	529	573	1,102	52.0

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The Basis of Plant Improvement*

This volume of the Encyclopedia Biologique is a serious effort to present not only the genetics of plant breeding but the biological background of plant and animal life. The work contains more than 500 pages and these pages are crowded with facts that vary in their range from chemistry to statistics.

The author's review of the known chemical and physical phenomena that form the basis of sexual reproduction is ably done. The statistical treatment is accorded less background than the biology but is clearly presented.

Despite the wide assortment of material included, M. Boeuf has fitted it into the picture he has tried to present. He has used many biological facts to develop a philosophy that is more than interesting. The book could be read much more rapidly if the text did not cause the reader to stop and think as frequently as is the case.

H. V. HARLAN.

* BOEUF, F. *Les Bases Scientifiques de l'Amelioration des Plantes.* Pp. 544. Price, 140 Francs. Paris: Paul Lechevalier. 1936.

HISTORY AND DEVELOPMENT OF MUTTON SHEEP IN GERMANY

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ORIGINATOR OF THE MELE BREED

Figure 10

H. L. Thilo holding twin lambs of the breed he has developed to meet the need of the German farmer for a dual purpose sheep. The mother of these lambs is only 16 months of age. In Thilo's Neuenkirchen flock, early maturity is a characteristic which has been stressed in selection. The Mele breed was derived from a cross between the Merino and the Leicester, the name being derived from the first syllables of the two names. The development of the dual purpose breeds was a response to economic conditions which made sheep raising mainly for wool unprofitable in Germany.

IN THE modern world few agricultural industries are entirely free from the influence of economic and political changes in other countries. This is exemplified in the changes which have taken place in the last 60 years in the kind of sheep which are raised in Germany. Thus, about a century ago the wool sheep reached its highest development in the Saxon Merino, whose fleece is generally conceded to be the longest and finest that has ever been produced. Forty years later, the situation had greatly changed, and by 1870 it became necessary for the German sheep breeders to abandon the breeding of sheep mainly for wool production and to go over to the breeding of mutton sheep or, at least, to the breeding of mutton-wool sheep. Wool could be produced cheaper in other countries, especially Australia and New Zea-

land. The opening up of new wool-growing regions brought about profound changes in the world wool market, and the German shepherd could no longer make a profit from wool alone.

From year to year the quantity of imported wool increased, and the price of home-grown wool was consequently forced downward until sheep-breeding at home became entirely unprofitable. Furthermore, the population of Germany increased enormously following the Franco-German war, and Germany developed into a great industrial country. Large cities grew out of small villages, and food production had to be doubled and tripled if Germany was not to rely entirely upon importations from foreign countries.

At this time the pure mutton breeds were being developed or had already been established. Large numbers of these, especially rams, were imported into Germany to be used on native and Merino sheep for improving the mutton qualities, and often even to create mutton qualities. In many cases these ends were not attained because the imported sheep did not seem to be hardy enough for German conditions: their feed requirements were too high for the German farmer, and they seemed to be very susceptible to lung diseases.

Behmer's ideal of the new type of sheep to be developed was one that would make the greatest use of its feed, be early maturing, have good fattening ability, produce a good grade of meat, make quick gains, and have a good mutton form. With regard to wool qualities, he stated that the grade of wool bringing the highest returns, without much consideration of fineness and fleece weight, should be produced.

Already in 1869 Behmer recommended the French "Merino-précocé," which was an early-maturing sheep, without any wrinkles, and a great meat producer. Its home was around the towns of Soisson and Chatillon-sur-Seine. It developed from the old French native sheep and merino-Rambouillets to which a very little Dishley-Leicester was added. In spite of its exceptional mutton qualities it carried a very fine wool. This fact disproved the often advanced theory that good mutton qualities could not be united with good wool qualities or vice versa. These French sheep therefore seemed to be very suitable for use on the fine-wool Silesian and other German Merino flocks to improve mutton qualities.

Behmer, Buchwald and Heyne were the first German breeders to import the French Merino-précocé. This was shortly before 1870. They were frantically opposed by other German breeders, who still believed that wool production was the primary purpose of sheep breeding and management. It is rather questionable that these Merinos are a pure breed. Without a doubt some English mutton breed, probably Dishley (English Leicester of Bakewell), has been used very carefully in developing the Merino-précocé breed.

In France there are two strains of the "Précocé" type. One is commonly known as Merino-Soissonais. These animals are large and heavy with a strong bone frame. They have a short face and great width between the eyes, and their ears are large and strong. The other strain is called Merino Chatillon or Burgundian Merino. It is composed of average-sized animals with a somewhat finer wool than that of the Merino-Soissonais. It is also claimed that their fleece weight is less. It has a beautiful body form and is beautifully balanced. Theoretically this is the ideal sheep, but in practice it has been found not to bring as great returns as the other strain. Also, in buying breeding stock it was only natural for the farmers to choose the larger and heavier type, as they wanted to increase the size and mutton qualities of their Merino flocks. For these reasons the Merino-Soissonais became the more popular strain of the two.

However, both strains were imported into Germany and both have been very

valuable for the increasing mutton production. Once established they became very popular, mainly because of their early maturing, quick growing, and good fattening abilities. Even today they are unsurpassed in both mutton and wool production.

All of the rams of these sheep had horns at the beginning. Heyne observed, however, in a few of the best French Merino flocks, that of the original animals which were imported from Spain a few rams were hornless, and that these were far superior in body conformation to the horned ones. This led him to believe that in breeding for mutton production and early maturity horns had gradually disappeared.

He decided, therefore, to found a stud flock of his own on his estate, Culm, near Sommerfeld in the Lausitz. He selected the ewes very carefully, and used only hornless rams, which he also selected very carefully from another of his stud flocks. Already in 1885 he was able to furnish great numbers of hornless Merino-précocé rams for other sheep breeders. Heyne also proved that these rams would produce strong and healthy hornless offspring, if they received good care.

In 1892 they were exhibited for the first time in Koenigsberg, East Prussia, at the German Agricultural Society Exhibition. Again in 1903 they were exhibited in Hanover, and the following year in Danzig; they won many prizes and were finally recognized as an outstanding mutton-wool breed. From that time on their popularity increased rapidly. They became known simply as Mutton-Merino sheep.

Mele Sheep

This breed was established about 1910 in Neuenkirchen. Hans Ludwig Thilo realized that a new breed of sheep had to be produced in order to save the German sheep industry from total failure. We have seen that Behmer, Buchwald, and Heyne had the same purpose in mind when they used the French Merino-précocé in obtaining a German mutton-wool Sheep. These men were only successful with their work since 1903. Thilo[7] speaks very favorably about the French Dishley Merinos, but states that their wool is lacking in quality and does not have a very good crimp. He thinks that the old French native sheep is responsible for this and probably also for the coarse wool of the Dishley-Leicesters.

Thilo tried for years to find among the English mutton breeds a breed which he could use upon his Neuenkirchen flock of pure Merinos. He aimed to use two extremes to obtain the type of sheep he had fixed as his ideal. He had his flock of highly developed pure Merinos. He tried unsuccessfully for a number of years to find a breed in France or England which was of a perfect mutton type and also had long, shiny wool with a well developed crimp. He used at first Bakewell's Dishley-Leicesters. He was not satisfied with them, however, because occasionally animals having dark-colored legs appeared. Since Bakewell never made any definite statements as to how he obtained his Dishley-Leicesters, Thilo believes that he used Southdowns at the beginning of the development of the Dishley-Leicester breed. Thilo states that economically the occasional appearance of individuals with dark legs is negligible, but that from the breeder's standpoint it is disturbing.

Nevertheless, he gave the Dishley-Leicesters a try, together with Cotswolds, Lincolns, and Ryelands. All the offspring of these crosses, however, showed distinct Merino characteristics, especially with regard to wool; consequently he had to continue his experiments to find what he really wanted. Besides the previously mentioned wool characteristics the desired sheep must have a long back and top, a good leg of mutton, and head and legs entirely white. This he finally found in the English Border-Leicester sheep, the home of which is in the boundary districts between England and Scotland. In his memoirs Thilo exclaimed, "Ihr

RAMS FROM THE STEIGER FLOCK AT LEUTEWITZ, GERMANY

Figure 11

The Steiger family has been world-renouned as Merino breeders for three generations. At the Leutewitz sheep-fold they have developed within the Merino breed a dual-purpose type, quite different from the small bodied, fine wool Merinos which a century ago produced "The Golden Fleece."

Anblick entzückte mich aufs Höchste. Eine herrliche Rasse!" He at once bought fifteen rams. He expected to earn the highest praise for this at home in Germany, but instead found much opposition among German fine-wool breeders. They argued that these sheep had hair instead of wool, and that they undoubtedly would ruin the old established pure breeds. They did not understand that Thilo was planning to produce a sheep which did not need to be protected from every rain shower and which could be herded on the sugar-beet fields late in the fall. The raising of sugar-beets has been to a great extent responsible, especially in Saxony, for the enormous decrease in number of sheep.

After a few years of successful work with these Border-Leicester sheep the arguments soon ceased to be heard, and Thilo now is supported by many German sheep breeders in the belief that the new breed is the next link in the development of Merino sheep breeding. If the farmer is to keep pace with the economic conditions of farming and of the country as a whole, a livestock breeding policy in close touch with economic conditions, and ready to produce types to meet changing demands is vitally important to the farmer.

Thilo's work proved highly successful, as he produced a sheep which is very robust, early maturing and easily fattened, with the inheritable factors for these traits well established.

German White-headed Mutton Sheep of Oldenburg

The home of this breed is in the district of Oldenburg. It is a long established breed. No one knows how it originated and where it came from. It seems to be quite certain, however, that some Cotswold blood was used to improve the mutton qualities. This probably occurred during the sixties and seventies of the last century, when Oldenburg carried on an extensive trade with England.

Since Oldenburg is a low-land and marshy country it was very natural for the livestock growers to try to obtain animals which would make the greatest use of their very good meadows and which were hardy and robust at the same time. The very distinct mutton character of these sheep has, since that time, been further consolidated by interested breeders without the

assistance of more Cotswold importations. The characteristics of this breed are laid down by the breeders' association and are as follows: Strong, well-balanced body conformities; a hornless, strong head; strong, well-placed legs, and a small tuft of wool on the forehead. The wool has to be fairly well-crimped, and to have a good staple and good luster. The legs must be white, although black spots are permitted on the ears, and the mucous membrane of the nose must be dark. Rams weigh from 275 to 330 pounds and ewes weigh from 220 to 275 pounds. In general the breeding aim is to produce a sheep which is entirely equal to the English mutton breeds, thus eliminating English mutton-sheep importations into Germany.

Ewe lambs may be bred at six months of age and consequently lamb at an age of eleven to twelve months. This does not injure their health and vigor at all. As a rule they have twins, but triplets and even quadruplets are not unusual. The animals remain on pasture during almost the entire year. Except during heavy snowfalls and during the lambing season they are never under shelter, which indicates that the breed must be very hardy.

The government of Oldenburg annually registers the rams, permitting the owners of registered rams to use them for breeding.

Würtemberg Bastard Sheep

This breed is also very old and has long been established as a pure breed. Nothing definite as to its origin is known. One source states that it originated from a cross of the straight-wool German native sheep with Merino sheep. Others say that it was developed from the old Flemish short-tailed sheep known as "Flameraare" which many years ago came to Würtemberg. Later it was crossed with Merinos. Even today the Würtemberg sheep show the influence of Merino blood, almost all the rams having the same kind of horns as have the Merinos. Also their wool has certain Merino characteristics, such as the uniformity of the crimp. However these sheep are much stronger than the Merinos.

No other country in Germany has an older history of sheep-breeding than has Würtemberg, for the manufacturing of wool is one of its oldest industries. Cities such as Ebingen, Göppingen, Heidenheim, and a few others, were places for cloth and dress manufacturing in the Middle Ages. In those times the old German straight-wooled sheep were kept, and even then sheep raising was on an organized basis. Rules and regulations for sheep raising were laid down by law in 1657. This law distinguished between different classes of herders, such as shepherds, master shepherds, etc. Two inspectors had to supervise all the flocks of the country. Even the ruling princes were much interested in sheep raising. It is said that the breeding experiments of King Wilhelm I showed much skill.

It was early recognized in Würtemberg that the raising of sheep with very fine wool would never be of great importance in that country, because the sheep had to be able to withstand a rather severe climate, had to stay in hurdles until late in the fall, be on winter pastures, and make long trips.

The influence of the Merinos was only of value insofar as it improved the wool quality considerably without the body being decreased. In breeding experiments with a flock of Würtemberg sheep at Hohenheim in 1830 it was sought to obtain a sheep which was suitable to rough management and which had a heavy, easily fattened body with a longer, coarser wool, soft and well-crimped, suitable for making cloth and combing yarn materials.

Up to the present time the direction of sheep breeding policies in Würtemberg has usually been in the hands of experts employed by the state. These have often been brought from famous breeding districts such as Saxony, to assist and advise sheep raisers, practically as well as theoretically. In 1920 the

Herd Book Association was founded in the city of Stuttgart, the Capital of Würtemberg. Annually a registration of rams takes place, and at the present time as many as twenty-three large flocks are under the supervision of breeding experts of the Chamber of Agriculture for that state.

The characteristics of these sheep are: White body and wool; a long, pointed, white head with wide, drooping ears; a face with a medium covering of wool; straight back; a wide, rather long body with good depth, well sprung ribs, and strong well-placed limbs. The old native sheep type may easily be recognized. The ewes are bred in August and September and lamb in January and February. Early in the spring the lambs are hardy and strong enough to go with the flock on long trips up to the cold mountain ridges of the Jura Mountains where they remain on summer pasture.

Ewe lambs are bred at an age of one and a half years. The average weight of matured ewes is 132 pounds and rams will reach a weight of 220 pounds and more. The average amount of grease wool in rams is about eleven pounds and in ewes eight and a half pounds. The wool is strong and from eight to eleven cm. long, measured on the animal.

Black-headed Mutton Sheep

This breed is of very recent origin. The breeders' association was founded in 1917 in East Prussia. This association was composed of the outstanding breeders of Hampshire and Oxfordshire sheep of East Prussia. The aim of the association is to unite the two breeds and develop a new one.

This was necessary because the German sheep breeders were not able to obtain new ram material from England during the war period. Since there were not enough breeders of either breed to continue the Hampshire and Oxfordshire breeding without new blood from England, it was sought to combine these breeds into a new one, which would make the German breeders entirely independent of importations.

The combination of these two breeds was very successful. The somewhat coarser Oxfordshire wool tends to become finer through the influence of the Hampshires, the wool of which is finer than that of the Oxfordshires. On the other hand, the new breed has a longer wool than the Hampshires, this being due to the Oxfordshires. Also with regard to body conformation and growth, these two breeds produce a cross which combines the outstanding qualities of both breeds, thus creating an ideal mutton sheep.

About 170 flocks are included in the Breeders' Association. They are annually inspected by a commission, which registers animals considered of breeding quality. The main points considered are type, body conformation, growth and size, wool, and constitution. The breeding aim in general is to produce a healthy, vigorous, quick-growing sheep, which, besides good mutton, also produces large amounts of a desirable grade of wool.

This breed probably will become the most important German mutton breed because of its ideal mutton qualities and its black face, which buyers always prefer.

In general one could say that in Germany the same conditions—small farms and intensive farming—prevail as are found in the Middle West of the United States, and mutton-type sheep which produce a fair quantity of medium quality wool seems to fit into such conditions most economically.

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